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SUPPLEMENT: THE PROBLEM OF REALITY IN PHYSICS—PROF. R. ORTVAY.

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CONTENTS.

Museums in India.

THE illustrated "Report upon the Museums and Art Galleries of India" recently issued by the Museums Association, as a result of the investigations conducted last year by Mr. S. F. Markham, Empire Secretary of that Association, and Mr. H. Hargreaves, former Director-General of Archæology in India, with funds from the Carnegie Corporation, deserves the careful attention of everyone who is interested in the raising through education of the cultural standard of the country. It contains not only the report proper, but also a 127-page directory of the museums, in which their scope, collections, publications, educational activities, staff and finance are carefully recorded. It is an outspoken document, often severely critical, but rich in valuable suggestions and by no means unmindful of the special difficulties that beset the museum movement in India.

One of the greatest difficulties is, of course, that of finance, for "on the whole of the Indian Museum Movement something less than Rs. 720,000 is spent per annum—less than is spent upon a single really good museum in any one of the great capital cities of Europe or America. The five richest Indian museums have a larger income than the remaining 100 put together, but even they with their *combined* incomes do not equal what is spent annually in Glasgow, Manchester, or a single one of the six large national museums in London. There is not a museum in India that can be regarded as adequately financed, and only a bare dozen can be considered as having finances even partially adequate to the task before them."

In British India about one twenty-eighth of an anna per head is spent annually upon museums, and in the Indian States only about the thirty-fourth of an anna, as compared with about 7½*d.* per head in countries like Great Britain and the U.S.A. But "The reasons for this

comparative poverty of museum finances are not far to seek. It must not be forgotten that India is essentially rural, and that although it has a population of 359,000,000 it has only 39 towns over 100,000 population compared with the 57 of the United Kingdom and the 74 of the U.S.A. Furthermore, the wealth per head is but a fraction of that of Europe or North America. Thus, whilst India as a country may be considered rich, the average individual lives at a scale so low that there is scarcely a European or North American equivalent. Whichever way one approaches the problem, however, it is evident that the finances of the museums of India whether in British India or in the Indian States, are much below those of almost any area in the world, and it is amazing what has been done, particularly at Bombay and Madras, on budgets below those of the principal provincial towns of the British Empire and the U.S.A."

In view of these facts, and of the difficulties under which the report shows curators to be at present working, the criticisms made lose much of their sting, but none of their importance.

The services that a museum should be rendering to the community for which it exists are classified as follows:—(1) Collection and preservation, (2) Interpretation, (3) Educational services. Concerning collection little is said, though it is made clear that in many museums much greater discrimination is required as to what is really worth preserving and what is not. Even as recently as 1935 the museum of one of the most educationally advanced cities in India—which shall be nameless here—"actually purchased 'A Monstrous Cow Calf'". But the account given of the way in which museum collections are—or rather, it seems, often are not—preserved bears out all too fully the conclusion "that many of India's most priceless treasures are not only deteriorating but are in fact disappearing from her museums" and that "while much needs to be done towards improving the curatorship of stone and metal exhibits, still more requires to be done towards improving the curatorship of textiles, books, natural history specimens and objects of wood and mixed materials. It is here that India has sustained and is sustaining her greatest losses. Carpets, uniforms, garments, manuscripts, maps, paintings, carvings and other minor evidences of India's past greatness are fast disappearing, to say nothing of the thousands of ethnological specimens that bear evidence of the lower stages of culture through which India has struggled."

Interpretation seems to be very much on a par with preservation. Labelling is apt to be woefully neglected or to be done mechanically instead of intelligently; guide-books are few and far between, as well as often being too highly priced with the result that they are apt to become hopelessly out of date long before the edition is sold out; and "only about twenty of the one hundred and five museums contribute anything towards an elucidation of their collections in terms of research publications, and only archæology receives anything like a fair share of attention. Thanks to the Presidency museums and those at Darjeeling and Nagpur, zoology is not entirely overlooked, but art, geology, ethnology, and particularly the arts and crafts of India are very much neglected, though the Jaipur catalogues do something to repair the omission in the case of the last named. Almost everywhere arms and armour were entirely unlabelled, and there seems to be little literature dealing with that subject, or at least little known to curators. Research in this direction would be of benefit to museums generally.....The poor labelling of most of the exhibits illustrating Indian arts and crafts reflects the want of complete and authoritative publications dealing with these, and there are very few museums which possess anything like a complete collection of the monographs on this subject issued from time to time by the various governments."

Educational facilities are even worse. Very few museums in India have ever organised systematic series of public lectures, and those that have attempted it seem to have discontinued the attempt for want of funds. "At many museums occasional lectures are given, but anything like an organised series of lectures for schools or students is apparently unknown in India, save at the Government Museum, Madras, "where in 1934–35 seventy teachers attended these demonstrations, and 4,516 pupils from some 130 schools in Madras and its suburbs were conducted over the Museum by their teachers

It is unlikely that all of these 4,516 children will necessarily yearn to repeat the performance, but some certainly will, and for such the museum will be a known and friendly place."

The Report necessarily deals "mainly with the shortcomings of the existing museum service, which stands in need of complete awakening and reformation, and little has been said about the excellent work of those individual museums in which curators and committees are endeavouring to pursue a vigorous and progressive policy. Some of these are large museums possessing splendid materials and making good use of them, others are small museums devoting themselves to the illustration of local history or to some other definite purpose, some again, both large and small, possess collections of objects of great rarity and value. Unless the existence and work of these museums is realised, an unfair picture will be obtained of the actual state of affairs. Even so, a great effort and considerable expenditure are required to set the whole service in order and to supply deficiencies."

So much for the picture. What, in view of the difficulties at present inherent in the situation, can be done to rectify the very serious defects that it reveals?

The greatest needs are briefly: better facilities for and greater discrimination in collecting; a better understanding and use of the methods available for the initial preservation of specimens (including good taxidermy); better methods of display, and the segregation in reserve collections of all material not definitely helpful to public understanding of the subjects illustrated in the galleries; greater care of collections (especially such as are readily perishable) for which an adequate knowledge will be necessary of techincal methods of checking any deterioration of which signs may appear, as well as constant vigilance; thorough and regular audit of specimens or at least of all those of great individual value; better labelling, including the use of explanatory labels as keys to different groups of specimens; adequate publications, including at least an interesting and intelligently written annual report from every museum detailing advances made during the year; cheap but interesting and well-written guide-books; and in every museum carefully organised educational services to schools in particular as well as to other interested bodies or persons.

In other words the prime necessity is a much higher general standard of curatorship, which can only be achieved by better trained curators with better status and pay, better facilities for their work and adequate opportunities for consultation with other curators through special conferences and occasional visits.

The qualifications required by a curator include, as the Report emphasises, a liberal education, administrative, literary and teaching ability, technical knowledge of various kinds and a real and inspiring enthusiasm for museum work. Such a combination is not easy to find, yet "Throughout India only a score of museums have what can be described as a full-time competent staff" while "At no less than one-third of the museums where the curatorial position is a full-time appointment the salaries are Rs. 100 a month or less, and at another third the salaries are Rs. 500 or below. These salaries are in sad contrast with those paid in the Dutch East Indies, Singapore and Ceylon." Comparatively few curators of Indian museums have, moreover, we believe had much real training in the curatorial side of their work, especially in the technicalities of effective conservation, having been selected mainly for their ability as archæologists, zoologists, etc., and all are severely handicapped by lack of time and effective assistance. "Archæological Chemists" are attached to the Archæological Survey and to a very few museums, some of whom are doing invaluable work, including research on the methods of preservation most suitable for various materials under tropical conditions. Some, on the other hand according to the Report, tend to confine their attention unduly to stone and metal—in which connection the designation "Archæological Chemist" comes in for criticism. Some curators, too, seem to expect these chemists to relieve them of all responsibility for preservation work. "And yet India can do well, for some of the sections in the museums at Bombay, Calcutta and Madras are of a very high efficiency, and the museums at Dehra Dun, Darjeeling, and the Archæological Museum at Gwalior, and the Sri Chitralayam at Trivandrum, show what work can be done by keen well-trained curators whose heart

is in their work, and who are not afraid to use their hands. This last phrase is fully meant, for one of the weaknesses of the Indian Museum Movement is the habit that has grown up of some officials passing on their duties to their subordinates."

Lastly, though the manifest advantages of the arts and sciences in India being fostered by Indians is clearly recognised, it is pointed out that the recent rapid replacement of European by Indian curators has one inherent drawback—the new men have much less personal touch than the old with countries in which the Museum Movement is more advanced than in India. "Thus, if the Indian curator is to keep abreast of his colleagues in other parts of the world, visits at not too distant intervals to other areas seem to be an absolute necessity." For this, as well as for visits to other museums in India, money will also be needed. "Finance is indeed the key to India's museum development; it is hopless to expect a great movement on fantastically low budgets."

In spite of the poverty already referred to of the average Indian individual, this fundamental problem of finance should not be insoluble. To expect India to spend anything like as much per head as England or the U.S.A. would clearly be ridiculous. But when neighbouring tropical countries like Ceylon, British Malaya and Java spend respectively a third, a half and a seventh of a penny per head annually on museums, surely India both can and should spend more than about a thirtieth of a penny. As a result of more adequate expenditure "The curatorship at Colombo, Singapore and Batavia is of a much higher level than that of the average Indian Provincial Museum: pests are kept down with a firm hand; labelling and arrangement will compare favourably with the best European models, and the research work is of a high order."

Further, with reference to the extreme rareness of private financial donations the Report stresses the fact that "This curious paucity of private benefactions cannot be due to any lack of fortune, for it is probable that a list of the hundred richest men in the world would include a dozen Indians".

"It should therefore be possible for the necessary funds to be made available if those who administer them, both governments and wealthy individuals, can be brought to realise that "Unless there is a change in the near future, proof of India's cultural greatness in terms of handicrafts will disappear before our eyes and the historian of the future will have to go to Europe for evidence that centuries ago India could weave, carve, compose and create superb objects of art and industry. Consideration of what should be done by the authorities in India to preserve for posterity her priceless treasures and to interpret them more adequately to the world can no longer be postponed."

Money alone, however, solves no problems. How should it be used? Clearly every curatorial post should carry enough pay to attract really efficient and well-qualified men, who must further have adequate facilities for their work. Without this no museum can prosper for long, and the report rightly recommends in no uncertain voice that useless museums should be closed. The securing of such men alone as curators would in itself ensure an improvement in their status such as is also needed since "probably in no part of the world has the museum service less capacity for, or opportunity of, making itself heard in the corridors and lobbies of Government, or of drawing attention to its urgent needs. In all India it is nobody's business to advise governments on Museums generally. They may be good, but no one can praise them and secure additional grants: they may be bad, deplorably so, but it is no one's business to condemn."

Existing curators, however, even those that leave much to be desired, cannot simply be dismissed, nor would that be right. Even the most promising new man would, moreover, find it a matter of almost superhuman difficulty to retain his enthusiasm and keep himself up to date and his mind alive in isolation and "In no part of the world is the curator so isolated as in India". Means have therefore to be found for providing continuous help to curators in overcoming such difficulties.

In the chapter headed "Conclusions and Suggestions" the Report says: "It has been already shown that the Central and Provincial Governments are responsible for nearly half of the Indian museums and for almost all the large and important ones. If, therefore, any real and lasting improvement is to be effected it will fall to the Government of India to take the first steps. That

the Government of India has recognised its obligations in this matter is evidenced by the resolution issued by the Governor-General in Council on the 22nd of October, 1915, wherein it is recorded that 'he also desires to see the museums of India developed on scientific lines and anticipates much profit from the periodic conference of museum authorities'. We suggest, therefore, that the Government of India should create a special appointment of Inspector-General of Museums (for a period of at least three years) holding a position similar to that of the Educational Commissioner with the Government of India, and acting in an advisory capacity. Such an appointment in the Department of Education would emphasise the educational aspect of museums." While recognising that very few museums are directly supported from central revenues, all authorities should avail themselves of his services, since " They can no longer keep their museums in watertight compartments and expect efficiency". He " should have had a European Museum experience and a wide grasp of the problems of museum work, from conservation to exhibition, from administration to research." He should see that every museum receiving a Government grant has an efficient curator, should make periodic inspections to enable him to advise as to developments and as to the possible closing of less successful museums, as well as to issue an annual report on the Museum Movement as a whole. " There should, in fact, be a definite Government policy towards museums, based upon the fundamental idea that it is the duty of the Government to provide for students and to preserve for posterity collections of scientific and artistic material. To do this the maintenance of museums of unquestioned efficiency is essential."

Another recommendation of fundamental importance is " The revival of the Standing Committee on Museums and Museum Conferences and the provision of funds to meet the cost of the Committee, travelling allowances involved and the necessary printing ". Periodical Museum Conferences at different museum centres would afford splendid opportunitues for curators to meet and intensify—in some cases perhaps renew—their interest, knowledge and enthusiasm, and might advantageously be held, we would suggest, in conjunction (but not simultaneously) with the meetings of the Indian Science Congress and the Orientalists' Conference in different years.

Many existing as well as future curators, moreover, will need scholarships and opportunities for special training, in the provision of which it is recommended that the proposed Inspector-General should also be concerned; and all will need funds for the purchase of necessary books if they are to carry out their duties efficiently. In this connection we should like to add a suggestion that the Governments, Central, Provincial and State, should agree to supply all their relevant monographs and serial publications, either free of charge or at some very small fraction of their published price, to every museum—and we would venture to add to every first grade college—in India, so long as they arrange to look after them properly. The country would thus obtain a wider use of the valuable books for the preparation and publication of which it pays, many of which we suspect at present remain unsold in the various presses for a considerable period. If this is the case the additional actual cost to the Governments concerned would be very small.

Other special recommendations, though of great importance are probably of less general interest. They relate to such matters as the need, already stressed above, for greater emphasis on the proper preservation of collections; more attention to the collection and proper preservation of important ethnological material, most of it extremely perishable, which is rapidly disappearing before the advance of modern civilisation; the imperative need for earthquake-proof buildings before the immense and valuable collections of the museums situated in the earthquake zone can be considered reasonably safe; the provision of a good museum in every town of 100,000 inhabitants; and the need for greater consideration being given to the education of the crowds of illiterates that visit the museums and cannot be reached through labels or books. In this last connection the Report remarks, " We feel that one of the first requirements of the Indian Museums Movement is the sympathetic study of the problem of the illiterate visitor. Throughout the world, and particularly in the United States and Europe, the most extensive enquiries have been made into

the psychological reactions of literate visitors to museums, and the recent investigations at the Buffalo Natural History Museum and others make it almost possible to predict how long a visitor will stand in front of a given case, and just which labels he will read ; but as far as we can discover nobody has ever given more than a passing thought to the problem of the illiterate visitor and his education by means of adapted museums." Perhaps those who go out in charge of vans for agricultural or other propaganda in the villages may have suggestion on this point that might usefully be passed on to museum curators.

The needs are vast and the available resources of the country slender. We agree with the Report in thinking that the amount allocated by the country to museums could and should be very greatly augmented. We also remember, however, the substantial help that has come to many museums both in Europe and in the East from trust funds such as the one that has financed this survey. Now that the Report has shown not only how great but also how urgent is the need, may we not, in view of the extreme poverty of the average Indian, look to these funds to supplement in some measure the resources of the country in implementing its recommendations ?

In conclusion, we commend the Report itself to the careful attention of all who are in any way interested in the preservation for future generations of India's cultural heritage, or in its present development, and not least to the various Governments. And we must heartily thank the two investigators for their valuable work, and the Carnegie Corporation for making it possible.

A Lecture to the Scientists.

WE have recently read extracts of the speech addressed by Lt.-Col. R. S. Weir, Director of Public Instruction, U. P., to the National Academy of Sciences, India, at its Annual Meeting held on the 15th January. If the press has reported the address faithfully, we have no hesitation in saying that the Director's utterances are as amazing as uncalled for, and, proceeding from an Officer who directs and controls the educational destiny of one of the most progressive and enlightened provinces in India, they are fraught with incalculable mischief, if pursued to their logical conclusion. It must be remembered that the members and fellows of the Academy have dedicated their lives to the pursuit of scientific researches, and some of them occupy the foremost ranks among the International Scientists, and all of them have made significant contributions extending and enriching scientific knowledge. We are bewildered that, in such a distinguished company, the Director of Public Instruction should have indulged in cheap sneers at their work and achievements. Criticisms so flagrantly wide of the mark are not likely to affect the prestige and reputation of the Academy whose glittering record has earned for it esteem and recognition both in India and abroad. We propose to deal with some of the extracts of Lt.-Col. Weir's speech.

" The Universities get larger and larger, their machinery is overloaded with their third class students, and their fields of instruction are widened. Their libraries grow larger year by year. There is much running to and fro. But few men seem to have the time to ask why they are attending the University or to what end all this accumulation of knowledge is directed.

" The attention of the public has been very forcibly directed of late to the absence of a plan in our educational system. In these provinces the expenditure from public funds on secondary and collegiate education is twice the expenditure on primary education. In consequence the market is overloaded with educated young men, qualified in philosophy and economics while the illiterate peasant toils humbly in his fields."

Those who are intimately acquainted with the progress of Education in India and her growing educational needs for a proper readjustment of the people's social and economic conditions, favour not only the growth and expansion of the existing Universities, but also emphasise the need and desirability of establishing such educational foundations in increasing numbers. The prevailing criticism of our Universities is that they do not offer sufficiently wide and diversified courses of instruction, and that they are too conservative and prone to restrict their studies to formal subjects, almost ignoring the modern sides.

We are unable to understand why the Director is harsh on the third class students; probably he is unaware that success or

failure in an examination supply no standards by which the promise of the future may be estimated. Originality of thought or achievement cannot be measured by the same units as those we use in testing the knowledge of prescribed text-books. Academic distinctions need not necessarily imply success in public life. The Universities do not exist to produce only stars of the first magnitude; they can justify their existence if they fill the firmament with illumination emitted by stars great and small. Third class students have often proved capable and worthy citizens and have contributed to the richness of public life.

Surely the Director of Public Instruction knows that Government is the greatest employer in India. In fact all employers place a great premium on the university diplomas and degrees for admission to service. The moment the employers withdraw this qualification for admission, probably the universities will cease to get "larger and larger", and all the students will then migrate to institutions which offer promise of careers and obviously this new "machinery must soon become overloaded". It will be interesting to know what the Director's views are in respect of the unemployment problem of the educated young men.

The Head of the Education Department should have realised that the expenditure of public funds on the different grades of education is proportional to the standard and the end expected to be attained by them. Primary schools obviously do not need the equipment and staff usually provided for secondary schools, which require much less than the colleges where original investigations are carried on. These institutions are in a progressive scale, just as the department has a hierarchy of officers. Would Lt.-Col. Weir accept a lower rate of salary for the reason that "the illiterate peasant toils humbly in his fields", which he alleges as a ground for retrenching the expenditure on secondary and collegiate education, or would he have the peasant and the philosophy graduate exchange places?

The whole speech is based on ignorance. The Director suffers from loose thinking.

We shall give one or two instances of both.

"A similar state of affairs seems to exist within the Universities—a lack of plan, of co-ordinated effort. There is no lack of funds—although Universities are always pleading poverty—and in the Budget ample provision is found for scholarships and research but in the direction of this provision things are not so satisfactory. There is no dearth of researchers. No lack of effort. But the result is largely an accumulation of educational lumber. The shelves of the libraries groan with papers that are of no use to anybody. The desire to see something in print rather than the desire to do something worth doing, something considered as contribution to a planned system, is responsible for the cluttering up of our laboratories with much useless material.

"Further I have no doubt that these research scholarships are a great temptation to young men who see no immediate opening in the world. The real spirit of the researcher is absent. Do these young men of to-day undergo difficulties and hardships, devise expedients, live dangerously, sacrifice anything or lack any comfort?"

Lt.-Col. Weir has manifestly a very queer concept of the meaning and influence of scientific research. He is confusing the accidental with the essential. No amount of poverty, hardship and self-sacrifice will produce the scientific spirit. It is born, and no born scientist is daunted by these circumstances when they confront him. Every school girl knows that scientific work is not inspired by any motive, and that the value of science is not to be measured by practical service, though its results might contribute to material prosperity. Every child knows that knowledge like most things has two sides, *viz.*, theoretical and practical, and that what is theoretical to-day may be used to-morrow for commercial gain or materialistic domination.

We have no doubt that if Col. Weir had been appointed to a research fellowship in any British University and had conducted a piece of original research, his language about the Indian Research Scholars would have been more restrained and better informed. It is perfectly ridiculous to maintain that the university budgets are prosperous, because they provide for a few scholarships, and it is equally ridiculous to say that "in the direction of this provision things are not so satisfactory", for the professors who initiate and direct the work of these scholars have by their labours earned for their universities a reputation as honourable and distinguished

as that enjoyed by any of the foreign seminaries of learning.

" The research scholar, flushed with the pride of his M.A. or M.Sc., potters around with some miserable question of whether the Huns were white, yellow or blue, peers through the microscope at the entrails of some inoffensive insect, proves that Kant could not have been serious when he wrote his *Kritik of Pure Reason*, and then unloads this stuff on a long suffering public."

" This is not real research and work of this type should be brought under control by the Academy. There is plenty of honest work to be done and the time and money spent on the present sterile research should be turned to better use."

" To what end should research be directed? Scientific knowledge has to be useful knowledge and not the sterile futile stuff that is piling up all over the world under the name research. Let the Academy show its approval of those who quietly and unostentatiously make their contribution to knowledge. Let it be frigid to the charlatan, the chatterbox, the politico-scientist. In other words let the Academy show its approval of honest work."

" And amid the numerous causes which the Academy may help let the foremost be that of serving mankind—India. To those who labour towards improving the conditions of life here, in India, let the Academy lend its full support. It is the duty of every one of us to remember that we are carried on the back of the peasant. We may administer, write, boil, bake, brew, teach or learn, work or idle but ultimately we must eat, and in eating we depend on the peasant. Then let our labours be directed to securing for the peasant, a better home, a better life, a better return for his labour."

" What I have said applies to all of us. We must get to work. Yet I learn that it is proposed in some quarters to limit the hours of teaching work of professors, of lecturers and of readers. One of my correspondents works out these proposed rules would limit the teaching of a professor to about ½ hour per day. Such regulations cast great discredit on the profession. They can be construed as exhibiting the worst features of trade unionism at its lowest ebb. Regulations of this type do much to foster the common belief and I shall be frank with you—that University posts are largely sinecures. And from the Universities this spirit of ' Ca Canny ', this acceptance of limitation of labour, of insistence on free periods, has spread to and corrupted the entire educational system."

We have quoted this long passage in order to show the extent of ignorance of its author in respect of the history of the progress of scientific investigation and the amount of loose thinking which must inevitably follow poor understanding. Surely Col. Weir must know the achievements which resulted from Sir Ronald Ross's peering through the microscope at the entrails of the apparently inoffensive insects. The problem of elevating the status of the peasant belongs to sociology and economics, while his industry involves researches in the physical and biological sciences. Investigations into any aspect of rural life must at first be theoretical, and the application of this knowledge for its improvement forms the second stage of scientific work. It is well known that all industries have grown out of researches in pure science, and if such knowledge is to be treated as " sterile and futile ", then obviously industries must be poor in standard and efficiency. If Col. Weir had taken more pains to think clearly and carefully, he would have been less caustic and more appreciative of the scientific work done in the Universities and the official departments. He wants the professors of the Universities to devote their time and intelligence to serve the cause of mankind in India by pursuing researches in useful knowledge, and at the same time he insists that they should be engaged in teaching all the hours of the week like the Rev. John Wesley in the School at Kingswood in 1750. Col. Weir has quoted from Louis Pasteur for the edification of his audience. If Pasteur had been working as the Rev. John Wesley did, would he have had time " to serve mankind "?

The whole speech is based on imperfect understanding of the functions of the different grades of education and of those who impart it, and on the complete misunderstanding of the purpose and significance of laboratory investigations. The only relieving feature of the address is that part in which Col. Weir professes a tender solicitude for the improvement of the peasant's lot, and the rest of it is amateurish.

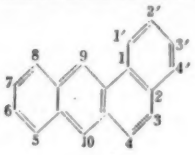
Cancer-producing Chemical Compounds.

By C. L. Hewett.

(*The Royal Cancer Hospital, London.*)

THE discovery of a group of chemical compounds having the power to induce malignant tumours in animals was the outcome of the recognition that coal tar has cancer-producing properties. The first experimental demonstration of this was due to Yamagiwa and Ichikwa[1] who, in 1915 produced cancer in the ears of rabbits by painting them with tar. Subsequent investigation of various tar fractions led Bloch and Dreifuss[2] to the view that the substance responsible for cancer was a high boiling neutral, nitrogen-free, picrate-forming substance. The production of strongly carcinogenic tars by the pyrolysis of isoprene or acetylene in an atmosphere of hydrogen[3] showed that a hydrocarbon could be responsible for the production of cancer and there was a strong presumption that the carcinogenic substance in coal tar was a hydrocarbon. A strongly carcinogenic product was also found[3] in the higher boiling fractions of the mixture obtained by the action of aluminium chloride on tetrahydronaphthalene.[4]

The observation in 1927 of Mayneord that the known carcinogenic mixtures were strongly fluorescent and each had a similar fluorescence spectrum with bands at 4040, 4270, 4540 Å (positions of short wave-length edges), resulted in the use of fluorescence spectrum as a guide in the isolation of the active material and in the selection of compounds likely to possess carcinogenic activity.[5] The fluorescence spectrum of 1 : 2-benzanthracene (I) was found to be very similar to those of a typical carcinogenic mixture, but the absolute wave-lengths differed, and in view of this a number of 1 : 2-benzanthracene derivatives were tested for activity by Kennaway and Hieger;[6] among these were 1 : 2 : 5 : 6-dibenzanthracene (IV) and its 3′-methyl derivative, prepared by the method of Clar.[7] These two compounds produced malignant tumours in the mice which were treated with them. 1 : 2 : 3 : 4-Dibenzanthracene, which was also tested in a slightly impure state, yielded only two tumours in 200 mice which had been treated with it over a period of 600 to 700 days.[8] 1 : 2-Benzanthracene itself showed very little activity.



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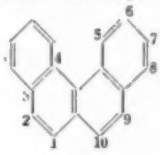

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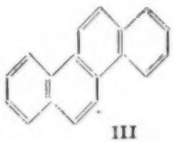

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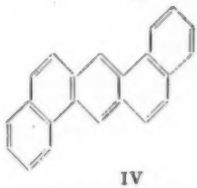


IV

A study of a series of 1 : 2-benzanthracene homologues has shown that carcinogenic

Compound	No of mice	Tumours	
		Epitheliomas	Papillomas
1 : 2-Benzanthracene	80	1	0
4-Methyl-1 : 2-benzanthracene	10	0	1
5-Methyl-1 : 2-benzanthracene ..	10	5	2
5-*n*-Propyl-1 : 2-benzanthracene	20	3	2
6-Methyl-1 : 2-benzanthracene	10	2	1
5 : 6-Dimethyl-1 : 2-benzanthracene	20	16	0
6 : 7-Dimethyl-1 : 2-benzanthracene	20	0	2
6-*iso*Propyl-1 : 2-benzanthracene	17	10	1
5 : 6-*cyclo*Penteno-1 : 2-benzanthracene	70	20	1
6 : 7-*cyclo*Penteno-1 : 2-benzanthracene	10	6	1

[1] Yamagiwa and Ichikawa, *Mitteil. med. Facultät, kaiser. Univ. Tokyo*, 1915, **15**, 295.

[2] Bloch and Dreifuss, *Schweiz med. Woch*, 1921, **2**, 1033.

[3] Kennaway, *Journ. Path. and Bact.*, 1924, **27**, 233; *Brit. med. Journ.*, 1925, **ii**, 1.

[4] Schroeter, *Ber.*, 1924, **57**, 1990.

[5] Hieger, *Biochem. Journ.*, 1930, **24**, 505.

[6] Kennaway and Hieger, *Brit. med. Journ.*, 1930, 250.

[7] Clar, *Ber.*, 1929, **62**, 350; see also Fieser and Dietz, *Ber.*, 1929, **62**, 1827.

[8] Cook, Kennaway, Hieger and Mayneord, *Proc. Roy. Soc.*, (B), 1932, **111**, 455.

activity is developed when an alkyl group is introduced into positions 5 or 6, or both in the molecule.[9,10]

Substitution in other parts of the molecule usually lessens the activity, thus 3′-methyl 1 : 2 : 5 : 6-dibenzanthracene is less active than the parent hydrocarbon. 2′ : 6-Dimethyl- and 3′ : 6-dimethyl-1 : 2-benzanthracene have given no tumours in mice.

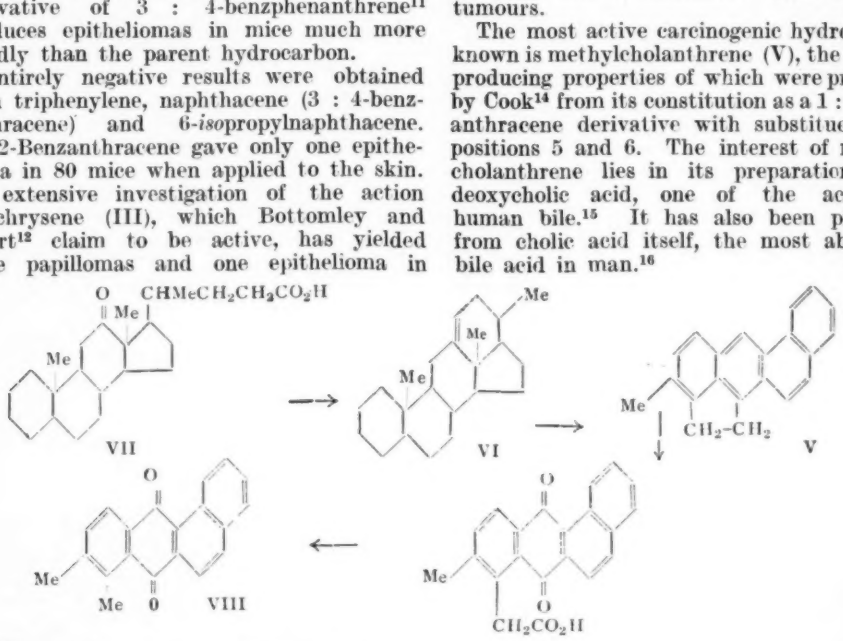
Experiments have been carried out with all the six possible aromatic hydrocarbons containing four six-membered rings.[10] In only one case was any evidence obtained of pronounced carcinogenic activity, 3 : 4-benzphenanthrene (II) producing 7 epitheliomas and 5 papillomas in 20 mice. The time of production is very long however, the first tumour making its appearance on about the 300th day. This is one of the few active carcinogenic compounds not related to 1 : 2-benzanthracene. In unpublished experiments it has been found that the 2-methyl derivative of 3 : 4-benzphenanthrene[11] produces epitheliomas in mice much more rapidly than the parent hydrocarbon.

Entirely negative results were obtained with triphenylene, naphthacene (3 : 4-benzanthracene) and 6-*iso*propylnaphthacene. 1 : 2-Benzanthracene gave only one epithelioma in 80 mice when applied to the skin. An extensive investigation of the action of chrysene (III), which Bottomley and Twort[12] claim to be active, has yielded three papillomas and one epithelioma in 290 mice using a specimen probably of coal tar origin. With pure synthetic chrysene in a series of 20 mice, 5 of which lived more than 440 days, one mouse died on the 853rd day bearing a large epithelial tumour which had appeared on the 711th day. This tumour showed some downgrowth but did not reach the superficial layer of voluntary muscle. No other mouse showed any tumour, hence the carcinogenic power of chrysene is of an extremely low order.

The three papillomas produced in 45 mice by pyrene may possibly have been due to a trace of impurity as the sample used was tinted slightly yellow.

Reduction of the ring system greatly reduces or destroys the carcinogenic activity; 9 : 10-dihydro-1 : 2 : 5 : 6-dibenzanthracene* has a very low order of activity and Schürch and Winterstein[13] have found that a tetrahydro derivative of 3 : 4-benzpyrene (a strongly active substance) produced no tumours.

The most active carcinogenic hydrocarbon known is methylcholanthrene (V), the cancer-producing properties of which were predicted by Cook[14] from its constitution as a 1 : 2-benzanthracene derivative with substituents in positions 5 and 6. The interest of methylcholanthrene lies in its preparation from deoxycholic acid, one of the acids of human bile.[15] It has also been prepared from cholic acid itself, the most abundant bile acid in man.[16]



[9] Cook, *Proc. Roy. Soc.*, (B), 1932, **111**, 485.

[10] Barry, Cook, Haslewood, Hewett, Hieger and Kennaway, *Proc. Roy. Soc.*, (B), 1935, **117**, 318.

[11] Hewett, *J.C.S.*, 1936, 596.

[12] Bottomley and Twort, *Amer. Journ. Cancer.*, 1934, **21**, 781.

* Evidence of the absorption spectrum showed that the sample used was probably contaminated with 1 : 2 : 5 : 6-dibenzanthracene. [Mayneord and Roe, *Proc. Roy. Soc.*, (A), 1935, **152**, 299.]

[13] Schürch and Winterstein, *Ztschr. Physiol. Chem.*, 1935, **236**, 79.

[14] Cook, *Proc. Roy. Soc.*, (B), 1933, **113**, 277.

[15] Wieland and Dane, *Ztschr. Physiol. Chem.*, 1933, **219**, 240; Cook and Haslewood, *Chemistry and Industry*, 1933, **38**, 758.

[16] Fieser and Seligman, *Journ. Amer. Chem. Soc.*, 1935, **57**, 228, 942.

The high activity of methylcholanthrene is shown not only by the early appearance of tumours, but also by the high percentage of animals which develop tumours. In one series of 20 mice, 18 tumours were obtained within 180 days. A tumour has also been obtained as early as the 31st day.

The conversion of a bile acid into a carcinogenic compound establishes a link between naturally occurring compounds and cancer, and is of interest since all the reactions employed in the preparation of methylcholanthrene are of a type known to occur in the human body.

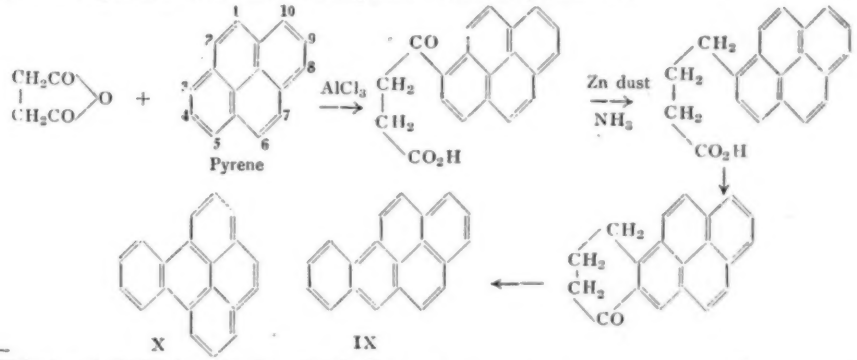
The hydrocarbon is prepared by the simultaneous dehydrogenation and elimination of two quaternary methyl groups of dehydronorcholene (VI), a product obtained by Wieland and Schlichting[17] by the elimination of water and carbon dioxide, by pyrolysis, from 12-ketocholanic acid (VII). Its constitution has been determined[18] by degradation to 5 : 6-dimethyl-1 : 2-benzanthraquinone (VIII) and further to 1 : 2 : 5 : 6-anthraquinonetetracarboxylic acid, both of which were identified by comparison with synthetic specimens.

The synthesis of methylcholanthrene was carried out in 1935 by Fieser and Seligman[16] by a method involving an Elbs' pyrolysis. The parent hydrocarbon, cholanthrene, has now been prepared by four different methods.[19, 20, 21] The most suitable method for preparing the hydrocarbon in quantity depends on the fact that 2-alkylnaphthalenes brominate mainly in the 1 position. The bromo compound obtained from 1-(2′-naphthyl)-hydrindene was converted, by the action of carbon dioxide on the Grignard compound, into corresponding carboxylic acid. Dehydration of this acid with strong sulphuric acid gave an anthrone which passed into cholanthrene on reduction.

Cholanthrene itself is a very active carcinogenic hydrocarbon. It has given 28 tumours of the skin in 50 mice, the first tumour appearing after 52 days and 11 after 110 days.[22] This hydrocarbon showed high activity in producing sarcomas when injected in the crystalline state.[23]

Before the discovery of methyl cholanthrene, it was noticed that certain coal tar pitch fractions contained a substance which was more active than any pure compound then known. Hieger[24] set to work to isolate the active constituent by a method of fractional distillation and crystallisation, using the characteristic fluorescence spectrum as a guide. From the high boiling fractions he obtained, after removal of acids and bases, an active material which gave a sparingly soluble picrate. The picrate decomposed to give a crystalline hydrocarbon mixture, which still retained the characteristic fluorescence spectrum to an enhanced degree.

From this crude hydrocarbon mixture was obtained a pure hydrocarbon by many crystallisations of the picrate.[25] This was shown to be 3 : 4-benzpyrene (IX) by comparison with a specimen synthesised in the following manner :—



[17] Wieland and Schlichting, *Ztschr. physiol. Chem.*, 1925, **150**, 273.
[18] Cook and Haslewood, *J.C.S.*, 1934, 428.
[19] Cook and Haslewood, *J.C.S.*, 1935, 767, 770.
[20] Cook, Haslewood and Robinson, *J.C.S.*, 1935, 667.
[21] Fieser and Seligman, *Journ. Amer. Chem. Soc.*, 1935, **57**, 2174.
[22] Cook, *Ber.*, 1936, **69**, 46.
[23] Shear, *Amer. Journ. Cancer*, 1936, **26**, 322.
[24] Hieger, *J.C.S.*, 1933, 395.
[25] Cook, Hewett and Hieger, *J.C.S.*, 1933, 396.

The isomeric 1 : 2-benzpyrene (X) which was also isolated from the same crude fraction, had very little, if any, carcinogenic activity.

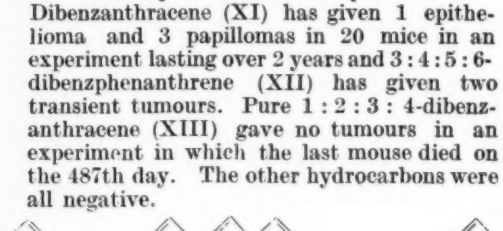
The fluorescence of 3 : 4-benzpyrene is so intense that it can be detected to the extent of one part in ten millions in solution. The pure hydrocarbon will produce tumours in mice in as little as 90 to 100 days,[10] and is now used in laboratories for the purpose of producing experimental cancer. In a series of 100 mice, 47 epitheliomas and 11 papillomas have been obtained.

The absorption spectrum of 3:4-benzpyrene is definitely of the 1 : 2-benzanthracene type, although some features of the pyrene spectrum may be detected.

Winterstein and Schön[26] have shown that 3 : 4-benzpyrene is present in the higher boiling fractions of coal tar in relatively high amounts.

Some details of the original synthesis of 3 : 4-benzpyrene have been improved by Fieser and Fieser[27] and by Winterstein, Vetter and Schön,[28] with consequent increase of yield. The 3′-methyl derivative has not produced any tumours after 270 days.[13]

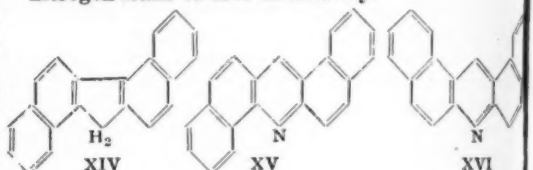
Of the 15 possible hydrocarbons containing five condensed benzene rings, only 12 are as yet known and these have all been tested on mice for carcinogenic activity. Of these 1 : 2 : 5 : 6-dibenzanthracene and 3 : 4-benzpyrene are the only two which have shown pronounced activity. 1:2:7:8-Dibenzanthracene (XI) has given 1 epithelioma and 3 papillomas in 20 mice in an experiment lasting over 2 years and 3:4:5:6-dibenzphenanthrene (XII) has given two transient tumours. Pure 1 : 2 : 3 : 4-dibenzanthracene (XIII) gave no tumours in an experiment in which the last mouse died on the 487th day. The other hydrocarbons were all negative.



XI XII XIII

Morton, Clapp and Branch[29] claim to have produced malignant tumours with s. triphenylbenzene and tetraphenyl methane.[30] 20 per cent. of the mice gave sarcomas in 250 days when injected *sub cutem* (0·5 per cent. in sesame oil) with triphenylbenzene. Tetraphenylmethane applied to the skin of mice gave epitheliomas after 319 days in one strain of mice, but not in another. The order of activity must, therefore, be very low.

Experiments carried out with compounds which resemble the carcinogenic benzanthracene hydrocarbons in molecular structure have shown that 1 : 2 : 5 : 6-dibenzfluorene (XIV), in which the central six-membered ring of 1 : 2 : 5 : 6-dibenzanthracene has been replaced by a five-membered ring, has given a small number of epitheliomas in mice after about 1 year.[22] Positive results have also been obtained with a number of heterocyclic compounds of structure analogous to these two hydrocarbons. 1 : 2 : 5 : 6-Dibenzacridine (XV) has a slight activity and 3 : 4 : 5 : 6-dibenzacridine (XVI) a rather greater activity, 11 epitheliomas and 2 papillomas being obtained in 40 mice, although the time required is nearly twice as long as that required by 1 : 2 : 5 : 6-dibenzanthracene.[10,31] Replacement of the second meso carbon atom by nitrogen leads to loss of activity.



XIV XV XVI

Sasaki and Yoshida[32] obtained tumours of the liver and papillomas and at least one carcinoma of the bladder in rats receiving *o*-aminoazotoluene (5 per cent. in olive oil) in their food (1 mg. of azo compound in one g. of food). More recently Otsuka and Nagao[33] used the deaminated product, namely 2 : 3′-azotoluene, and obtained tumours of the bladder in a high percentage of the rats. This result is of considerable interest in connection with the abnormally high incidence of cancer of the bladder among workmen engaged in the manufacture of coal tar dyes and intermediates.

[26] Winterstein and Schön, *Naturwiss.*, 1934, **22**, 237.
[27] Fieser and Fieser, *Journ. Amer. Chem. Soc.*, 1935, **57**, 782.
[28] Winterstein, Vetter and Schön, *Ber.*, 1935, **68**, 1079.
[29] Morton, Clapp and Branch, *Sci.*, 1935, **82**, 134.
[30] Morton, Branch and Clapp, *Amer. Journ. Cancer*, 1936, **26**, 754.
[31] Rondoni and Corbellini, *Tumori*, 1936, **10**, 106.
[32] Sasaki and Yoshida, *Virchow Arch.*, 1935, **295**, 175.
[33] Otsuka and Nagao, *Gann*, 1936, **30**, 561.

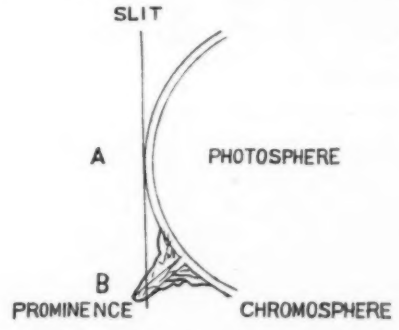
LETTERS TO THE EDITOR.

Oxygen in Solar Prominences.

At the total eclipse of 1925 Curtis and Burns[1] observed the infra-red O triplet as a single line in the chromospheric spectrum and stated that "it is very strong at low levels and weaker at higher levels, though faintly present in a high prominence".

Since one of us showed in *Kodaikanal Observatory Bulletin*, No. CVII, that it was possible to observe the O triplet in the chromosphere in full daylight, it seemed desirable to examine whether the O triplet could be seen reversed as bright lines in prominences also without an eclipse. It would be necessary to observe near the base of a prominence for the sake of obtaining sufficient intensity, and yet we must be able to prove that light from the chromosphere did not reach the slit at any time during the exposure.

In order to ensure that any effect observed was really due to a prominence and not to the chromosphere, it was arranged that the slit was tangential to the sun at a point near the prominence as illustrated in the figure. The guiding of the sun's image, which was controlled by visual observation of the H_α line, was so arranged that at the point A the chromosphere was either just on or just off the slit during the whole period of exposure. The distance AB was large enough that the chromosphere could



not reach the point B without photospheric light hopelessly fogging the plate at the point A.

The sky background, of course, always shows the O triplet as dark lines along the whole length of the slit due to the scattered sunlight, and for reversals to be seen as bright lines they must be stronger than this background spectrum. In no prominence observed hitherto has the O triplet been strong enough for this, but we have photographed many examples where the

O triplet partially reversed at the point B, *i.e.*, the dark lines of the O triplet at this point are markedly fainter than in the sky spectrum due to faint bright reversals in the prominence. None of these examples are suitable for reproduction but we regard the partial reversal seen in many examples at the point where the prominence is on the slit as demonstrating the existence of O in prominences. The distance AB is a measure of the height of the observed point in the prominence, and we have obtained partial reversals of the O triplet in prominences at a height of 10″ above the upper surface of the chromosphere.

The presence of O in prominence is another blow to the theory of their being supported by radiation pressure, for this makes still another element present in far greater abundance than Ca^+ on which alone can radiation pressure be appreciable.

We also attempted to photograph reversals of the O triplet in flocculi on the disc but have not hitherto been able to obtain convincing evidence.

T. Royds.
A. L. Narayan.

Kodaikanal Observatory,
March 10, 1937.

[1] *Publications of the Alleghany Observatory*, 1925, **6**, 95.

Effect of Temperature on the Wing Accompanying Rayleigh Scattering in Liquids.

Recently Bhagavantam and Rao[1] have reported that there is a considerable weakening in the absolute intensity of the wing accompanying the Rayleigh scattering in benzene as we pass from the vapour to the liquid state. In an attempt to investigate this phenomenon more fully and to follow it up by stages, a study is made of the λ 4358 Rayleigh line in the liquid at different temperatures. The scattered spectrum of benzene contained in an exhausted and sealed pyrex glass tube is recorded once at the laboratory temperature and again at 210° C. under the same conditions of illumination, slit width, etc. The times of exposure are so adjusted that the intensity of the vibration line 990 is nearly the same in both pictures. The liquid is under a pressure of about 18 atmospheres at the higher temperature but the tube is specially made out of thick-wall glass so as to withstand the pressure. In Fig. 1

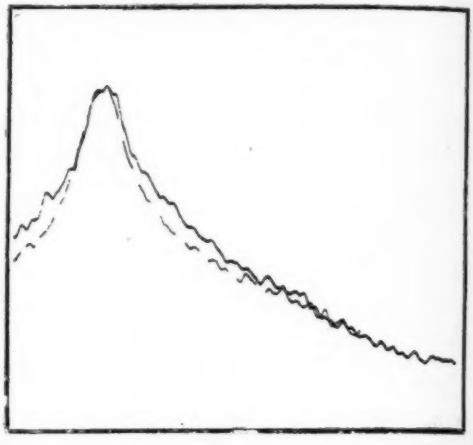


Fig. 1.

which is a microphotometric record of the λ 4358 line, broken curve relates to the low temperature whereas the continuous curve relates to the high temperature. The following conclusions are drawn from Fig. 1. At higher temperatures the extent of the wing does not alter, there is no increase in intensity in the external portions of the wing and the wing confined between 20 and 50 wave-numbers from the centre shows a marked increase in intensity.

Amongst others who have worked on similar lines, mention may be made of Gross and Vuks[2] who have studied this problem in the case of diphenyl ether. The extreme temperatures used by them are 18° C. and 250° C. and the results obtained by these authors are entirely similar to those reported in the present investigation. Veerabhadra Rao,[3] however, found that the intensity of the wing in all regions remains unchanged with increasing tempreature. This is evidently due to the fact that he has not heated the liquids beyond their boiling points and in the case of benzene the range adopted by him, namely, 30 to 80° C., is particularly narrow. Sirkar and Maiti,[4] on the other hand, obtained entirely different results as they found a distribution of intensity in the wings of liquid benzene similar to that obtained in gases both at the room temperature and 210° C. These

results are not confirmed by other investigators.

The results of Gross and Vuks on diphenyl ether as well as those of the author in benzene indicate that the liquid wings generally consist of two distinct parts which behave differently on heating. The outer portions possess features characteristic of the vibrational Raman scattering as they exhibit no increase in intensity when conditions are so arranged that the intensity of the vibrational Raman lines is kept constant. On the other hand, the intensity of the wing in regions closer to the centre increases under similar conditions suggesting that it is of a different origin. The increase may reasonably be correlated with the fact that the effective anisotropy of the liquid molecules increases with increasing temperature.

K. BAPAYYA.

Department of Physics,
Andhra University,
Waltair,
April 1, 1937.

[1] *Proc. Ind. Acad. Sci.*, **1937**, **5**, 18.
[2] *Jour. d. Phys.*, **1935**, **6**, 457.
[3] *Proc. Ind. Acad. Sci.*, **1934**, **1**, 274.
[4] *Ind. Jour. Phys.*, **1934**, **9**, 323.

Diamagnetic Susceptibility of Heavy Water.

THE values for the diamagnetic susceptibility of heavy water (D_2O) obtained by different workers, do not agree among themselves.[1] A sample of 99·5 per cent. heavy water being available in the laboratory, its diamagnetic susceptibility was determined, employing Gouy's method. Full details of the apparatus used are described in a paper dealing with the diamagnetic susceptibility of formic and acetic acid solutions, to be published shortly elsewhere. Calibration experiments carried out with conductivity water, benzene and acetone, gave values for the constant which agreed to within 0·5 per cent. After correcting for the presence of ordinary water, assuming linear variation with percentage concentration, the mass susceptibility of pure heavy water was found to be $0{\cdot}638 \times 10^{-6}$ at a temperature of 29°C. This value is in close agreement with those of Cabrera and Fahlenbrach[2] and Trew and Spencer[3,4] but differs from the value found by Hoar[1] by about 1·5 per cent. The values obtained by different workers are given below :—

Author	% of D_2O employed	$-\chi \times 10^6$
Hoar	99·2	0·648 ± 0·004
Selwood and Frost[5] ..	92·0	0·644
Cabrera and Fahlenbrach..	99·0	0·637
Trew and Spencer ..	99·2	0·637 ± 0·001
Authors	99·5	0·638

Our thanks are due to Norsk Hydro-Electric Kvoelstofaktieselskab, Oslo, for supplying free of cost the sample of heavy water used for these measurements.

V. NEHRA.
M. QURESHI.

From the Department of Chemistry,
Osmania University,
Hyderabad (Dn.),
April 8, 1937.

[1] Hoar, *Nature*, **1936**, **137**, 497.
[2] Cabrera and Fahlenbrach, *Naturwiss.*, **1934**, **22**, 417.
[3] Trew and Spencer, *Nature*, **1936**, **137**, 706.
[4] Trew and Spencer, *Ibid.*, **1936**, **137**, 998.
[5] Selwood and Frost, *J. Amer. Chem. Soc.*, **1933**, **55**, 4335.

Estimation of Rice Yields by Sampling.

THE estimation of yields of crops from field experiments by means of random sampling of the plots, instead of harvesting them whole is becoming increasingly popular in England. Studies enunciated by Clapham[1] and further developed by Kalamkar,[2] Clapham[3] and Yates and Zacopanay[4] have done much to popularise as well as to standardise the mode and apparatus of conducting analysis by the sampling technique. In America, Immer[5] has utilised sampling methods in studying sugar content of sugar-beets. Prior to the development of the random sampling method, Hubback[6] determined yield of rice by sampling on a very extensive scale in Bihar and Orissa. As there are possibilities of the random method becoming popular in India we considered it of interest to report briefly our studies in rice.

In the season of 1936 a number of rice fields in the vicinity of Karjat were sampled. For sampling, plots of 33′ × 33′ (1/40th of an acre) were first marked out in the rice fields. Each plot was further sub-divided, north to south, in 3 sub-plots and from each sub-plot 3 samples were taken at random. There were therefore 9 samples from each plot. The sampling unit was 3′ × 3′. The number of bunches and number of ears in the unit area were also recorded. After sampling, the remaining plot was harvested and yield of grain and straw of the whole plot determined. Altogether 41 plots were sampled, but data on 39 plots only were available, as yields of two plots were mixed up inadvertantly.

The analysis of yields of the plots indicated that in a few cases the division into sub-plots was advantageous, while in most cases the variance between sub-plots (D.F. 2) was smaller than within sub-plots (D.F. 6). The pooled estimate of variance is shown in Table I.

TABLE I.

Analysis of variance of sampling yields.

Due to	D.F.	Variance
Plots	38	482·84
Sub-plots	78	31·81
Samples	234	44·07

It will be seen that the variance due to "between plots" is much greater than that "between sub-plots" or to that "between samples", indicating great soil variability from plot to plot. The plot error per sampling unit is 21·97 or 63·30 per cent. of the mean and for the mean of 9 such sampling units the plot error is 21·10 per cent. The sampling error per sampling unit is 6·33 or 19·14 per cent. and for the 9 samples it is 6·38 per cent.

The "non-sampling" error, *i.e.*, the error if the whole area had been sampled, comes to 20·20 per cent. of the mean while the actual, as obtained from the actual yields of the whole plots, is 23·06 per cent. Thus the agreement between the two is good.

The mean yield per sampling unit was 34·69 quarter ounces as compared to 34·38 calculated from the total harvest. The correlation between the sampling yield per plot and that obtained by total harvest is 0·866. The sampling technique used by us furnished 92 per cent. of the total information. The detailed account of the experiment and its significance will appear elsewhere.*

B. S. KADAM.
R. J. KALAMAR.
V. K. PATANKAR.

Karjat,
March 18, 1937.

[1] Clapham, *Jour. Agric. Sci.*, 1929, **19**, 214.

[2] Kalamkar, *Jour. Agric. Sci.*, 1932, **22**, 783.

[3] Clapham, *Jour. Agric. Sci.*, 1931, **21**, 366; 376.

[4] Yates and Zacopanay, *Jour. Agric. Sci.*, 1935, **25**, 545.

[5] Immer, *Jour. Agric. Res.*, 1932, **44**, 633.

[6] Hubback, *Agric. Res. Inst. Pusa Bulletin*, 1927, No. 166.

* Thanks are due to Dr. L. A. Ramdas, Agricultural Meteorologist, Poona, for allowing one of us (R. J. Kalamkar) to co-operate in the investigation.

Fibrous Tourmalines from the Mysore State.

A FEW samples of tourmaline which were kindly presented to the author by the Director, Mysore State Geological Department, formed the material for investigation. Some of the specimens presented a distinctly fibrous structure. A chemical analysis of these specimens was, therefore, undertaken with a view to find out the difference, if any, in the chemical nature of this fibrous mineral from the ordinary crystalline varieties of tourmaline. The results obtained are given in Table I.

CHEMICAL COMPOSITION OF THE SPECIMENS.

Method of Analysis.—The usual methods employed for investigation of tourmalines were studied with a view to ascertain those most suitable for the determination of boron and fluorine. The methods employed were as follows:

The method devised by Gooch[1] of distilling off the boron with methyl alcohol and weighing as calcium borate was tried with synthetic mixtures of known proportions of silica, boric acid and calcium fluoride and was found to yield accurate results. This method was therefore adopted.

Fluorine was determined by the lead chlorofluoride method of Hoffman and Lundell.[2]

Alkalies were determined by the usual Lawrence-Smith method, but the residue after removal of ammonium salts was evaporated with methyl alcohol to free it from any borate that might possibly be present.

Water was determined by heating the mineral placed in a porcelain boat in a combustion tube, employing the usual precautions and collecting the water obtained in a weighed calcium chloride tube. The results obtained are given below:

TABLE I.

Specimen	A	B	C	D
	%	%	%	%
SiO_2 ..	34·64	34·00	33·20	35·38
TiO_2 ..	0·35	0·52	0·24	0·80
FeO ..	8·00	9·88	11·63	12·20
Al_2O_3	38·90	38·28	41·54	34·56
CaO ..	0·36	1·59	1·53	1·36
MgO ..	3·39	5·74	0·59	2·48
Na_2O ..	3·70	0·50	1·53	1·16
H_2O ..	0·90	1·00	1·00	1·76
F ..	n.D	n.D.	nil	0·33
B_2O_3 ..	9·1	8·01	8·00	9·90
MnO ..	nil	nil	0·02	nil
	99·34	99·52	99·28	99·93

Specimen A is a black variety of crystalline tourmaline occurring as individual crystals. An analysis of this sample is inserted here with a view to compare this with those of B, C and D, which represent various tages from a semi-fibrous to a completely fibrous variety of tourmaline. It appears from the above analysis, that the chemical composition of the fibrous tourmalines is not very different from that of the ordinary crystalline types, indicating that the fibrous structure may not be due to any important change in the chemical composition of the mineral. This view is, however, purely tentative as the specimens examined are not from the same locality. Further work in this direction is in progress and an investigation of the crystal structure of the mineral by X-rays is also being conducted in the Physics Department of this Institute.

The author wishes to gratefully acknowledge the constant help and guidance received from Dr. K. R. Krishnaswamy during the progress of this work. Thanks are also due to the Director, Mysore State Geological Department, for the kind gift of the above specimens.

K. Y. Sreenivasa Iyengar.

Department of General Chemistry,
Indian Institute of Science,
Bangalore,
March 1, 1937.

[1] *Am. Chem. Jour.*, **9**, 23.
[2] *Bureau of Standard Jour. of Research*, 1929, **3**, 581.

A Note on the Development of the Embryo-Sac in *Phyllanthus niruri* Linn.

A monosporic embryo-sac of the 4-nucleate type is known at present in three families: Oenotheraceæ (all genera except *Trapa*[1]), Euphorbiaceæ (*Codiæum*, *Ceramanthus* and *Glochidion*[2]), and Liliaceæ (only *Clintonia borealis*[3]). Recently the same type of development was reported by Miss Parks (1935)[4] in *Commelinantia Pringlei* and *C. anomala*, but her statements do not at all appear to be convincing and other members of the Commelinaceæ are known to have the normal type of embryo-sac. Kusano's (1915)[5] observations on *Gastrodia elata* also demand a revision.

The ephemeral nature of the antipodals (cells or nuclei) has misled several authors to imagine that they are not formed at all and that they were dealing with genuine 5-nucleate embryo-sacs with only an egg apparatus and two polar nuclei. Thus, Rutgers (1923)[6] believed that there were only 5 nuclei in the embryo-sac of *Moringa oleifera* while Puri (1934)[7] has now demonstrated that all the eight are formed. Haeckel (1930)[8] likewise originally failed to observe the antipodals in *Sisyrinchium anceps* but was able to detect them afterwards.[9] Among cases of this kind which deserve reinvestigation, we may specially cite the following: *Garcinia Kydii* and *G. Treubii* (Treub, 1911)[10] *Monophyllæa Horsfieldii* (Ochlkers, 1923),[11]

Chamædorea concolor (Suessenguth, 1920)[12] and *Linaria genistæfolia* (Persidsky, 1934).[13] The last-named author makes the ambiguous statement that the antipodals are apparently not formed at all!

Of the Euphorbiaceous plants supposed to have a 4-nucleate embryo-sac by Arnoldi (1912)[2], *Codiæum variegatum* has already been shown to be normally 8-nucleate by Lundberg (1931)[14] and may be struck out of the list. The mistake was evidently due to the fact that the antipodals are very ephemeral and polar fusion takes place early. The designation "*Codiæum*-type" of embryo-sac, used by Palm (1915)[15] and Wettstein (1935) has now to be definitely discarded in favour of Schnarf's "*Oenothera*-type".[16]

Our own investigations on *Phyllanthus niruri* show that the primary parietal cell is cut off in the usual way and the megaspore-mother cell becomes covered by several layers formed by its divisions. It undergoes the usual reduction divisions and produces a tetrad of megaspores or a row of three cells of which the lower two are megaspores and the upper an undivided dyad cell. Here we wish to point out that a row of "two" or "three megaspores", often described in embryological literature on the embryology of Gymnosperms and Angiosperms, is theoretically impossible. Megaspore formation can be said to be over only after both the reducing divisions have taken place. The two cells formed after the first reduction division are dyad cells and *not* megaspores; when there is a row of three cells at the end, one *must be* an undivided dyad.

In every case the chalazal cell was found to function and its nucleus undergoes the usual three divisions to form 8 nuclei arranged in two quartets. A favourable slide showed all the four spindles of the last division and this leaves no doubt that the development is perfectly normal. Indeed, on looking over the literature on the subject, we found later that Modilewski (1910)[17] also figured an octo-nucleate embryo-sac in *P. angustifolius*, although he failed to observe all the stages leading to its origin.

Arnoldi (1912)[2] makes no mention of the particular species of *Ceramanthus* (= *Phyllanthus*) which he investigated, but in view of the observations reported here, it is hardly to be doubted that his plant was also normal and he overlooked the antipodals due to inadequacy of material of the right stage. The same may perhaps be said of *Glochidion*, which, however, still remains to be reinvestigated.

An interesting feature in the ovule of *Phyllanthus* is the presence of a nucellar beak of the type found by Miss Lyon (1898)[18] in *Euphorbia corollata*. The obturator is of common occurrence in the family and is present here also.

As pointed out by one of us (Maheshwari, 1937) it is possible to place a different and perhaps more correct interpretation on Smith's (1911)[3] figures of *Clintonia borealis*, which would leave the Oenotheraceæ as the only family having a monosporic tetranucleate embryo-sac. And, this has been found to be such a constant and characteristic feature here, that *Trapa*, which is the only exception, may rightly be kept apart (on embryological grounds too!) in a different family, the Hydrocaryaceæ.

P. MAHESHWARI.
Berlin, O. R. CHOWDRY.
February 24, 1937.

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[1] Maheshwari, P., *A Critical Review of the Types of Embryo-Sacs in Angiosperms* (in the press).

[2] Arnoldi, W., *Trav. Mus. Bot. Acad. St. Petersburg*, 1912, **9**, 136.

[3] Smith, R. W., *Bot. Gaz.*, 1911, **52**, 209.

[4] Parks, M., *Bull. Torr. Bot. Club*, 1935, **62**, 91.

[5] Kusano, S., *Jour. Coll. Agri. Imp. Univ. Tokyo*, 1915, **6**, 7.

[6] Rutgers, F. L., *Ann. Jard. Bot., Buitenzorg*, 1923, **33**, 1.

[7] Puri, V., *Proc. Ind. Acad. Sci.*, (B), 1934, **1**, 279.

[8] Haeckel, J., *Flora*, 1930, **125**, 1.

[9] Private communication to one of us (P. M.) during the course of a personal talk in Germany in February, 1937.

[10] Treub, M., *Nouv. série des recherches. Ann. Jard. Bot. Buitenzorg*, 1911, **24**, 1.

[11] Oehlkers, F., *Beih. Bot. Centralbl.*, 1923, **39**, I Abt., 128.

[12] Suessenguth, K., Diss. München, 1919.

[13] Persidsky, D. J., *Bull. Jard. Bot. Kieff*, 1934, **17**, 11 (In Russian with English summary).

[14] Lundberg, F., *Bot. Not. (Lund.)*, 1931, 346.

[15] Palm, Bj., "Studien ueber Konstruktionstypen und Entwicklungswege des Embryosackes der Angiospermen," (Diss. Stockholm).

[16] Schnarf, K., *Embryologie der Angiospermen*, Berlin, 1929.

[17] Modilewsky, J., *Ber. Deutsch. Bot. Ges.*, 1910, **28**, 413.

[18] Lyon, F. M., *Bot. Gaz.*, 1898, **25**, 418.

Formation of a Quadrivalent Group in a Hybrid between *Triticum vulgare* and a *Tr. vulgare* extracted Derivative.

A *Tr. vulgare* type with $2n = 42$ chromosomes, extracted from a *vulgare-monococcum* hybrid (Kostoff, 1935)[1] was crossed with "normal" *Tr. vulgare*. During the first meiotic metaphase in the pollen-mother cells of the hybrid obtained, a quadrivalent group of chromosomes was very often observed. This phenomenon can be most probably interpreted by assuming exchange of parts (crossing-over) between two partially homologous chromosomes, obviously of B and C genoms in the F_1 hybrid *vulgare-monococcum* (Fig. 1—I, II, III and IV). In this hybrid as well as in *Tr. vulgare-Secale cereale* hybrid (Lebedeff, 1933),[2] autosyndesis was found obviously between the chromosomes of B and C genoms. The appearance of bivalent chromosomes in haploid *vulgare* (Gaines and Aase, 1926)[3] also indicates that autosyndesis may occasionally take place in *vulgare* when its genoms are in haploid condition. The derivative *vulgare*, that we crossed, seems to have one cross-over chromosome (C′), because no ring of four chromosomes was found but a chain with two somewhat larger and two somewhat smaller members. In all of the cells studied two of the chromosomes (1, 3) were directed to the one pole and the other two (2, 4) to the other pole. Only in one metaphase plate one chromosome was directed toward the one pole (2), while the other three were directed to the other pole (1, 3, 4). The interpretation is diagrammatically represented in Fig. 1.

Considering the above described phenomenon and the interpretations advanced, it can be inferred that the enormous number of forms produced in wheat species crosses and in crosses of wheat with allied genera is due not only to gene recombination between homologous chromosomes from the homologous genoms but also to the exchange of parts between partially homologous chromosomes from *vulgare* genoms autosyndetically (Duplication-deficiency). (Compare also Winge 1924;[4] and Kostoff, 1935[5].) Parallel with these the exchange of parts between non-homologous chromosomes (Belling, McClintock) as well as the increase mutation frequency following hybridisation (Belgovsky, Kostoff) should also be considered.

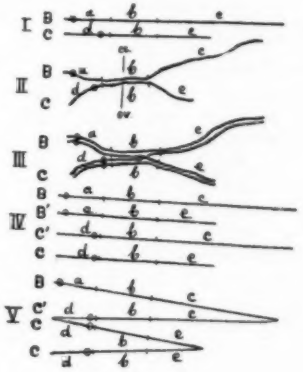

Fig. 1.

I, II, III and IV—in *vulgare-monococcum* hybrid. V—in the hybrid between the extracted derivative and "normal" *vulgare*. I—chromosomes B and C (one might be from genom B, the other from genom C) have a small homologous segment "*b*". II—leptotene, homologous segments attract each other, "*cr. ov.*"—the place where crossing-over takes place. III—diplotene (also autosyndetic bivalent with one chiasma). IV—second anaphase—two normal chromosomes (B and C) and two cross-over chromosomes (B′ and C′). V—a quadrivalent consisting from three normal (B, C, C) and one cross-over chromosome (C′).

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[1] Kostoff, Dontcho, *Compt. Rend. Acad. Sci. USSR*, **1935**, T.1, No. 2–3, 155.

[2] Lebedeff, V., "The phenomena of Autosindesis in intersp. hybrids of *vulgare* wheat", Kharkov, **1933**.

[3] Gaines, E. F., and Aase, H. C., *Amer. Journ. Bot.*, **1926**, **13**, 237.

[4] Winge, O., *Hereditas*, **1924**, **5**, 241.

[5] Kostoff, Dontcho, *Sbornik Ceskosloven. Akadem. Zemedels.*, **1935**, **10**, 389.

Perennation in *Cuscuta reflexa* Roxb.

OF all the Indian species of Dodders, *Cuscuta reflexa* appears to be hardier than others in attacking herbaceous as well as woody plants. No perennial *Cuscuta* has been reported from India, all the species being annuals like the European dodders.[1] One exception is *Cuscuta verrucosa*, which grows under the tropical sun and functions

throughout the year, wherever it has once attacked the host.[2]

Cuscuta reflexa parasitic on *Strobilanthus gossypinus* and *S. canaricus* over large areas in the sholas of Mysore forests has been observed to exhibit an interesting new method of perennation and growth. It grows rapidly during the rainy months of the year and after flowering gradually disappears. By the time the summer sets in, nothing is seen of the parasite till the next monsoon, when it makes its appearance again. Short period of rainless summer is passed by the parasite by two methods. First is the usual seed formation and the second is the perennation described below. At the beginning of summer, the parasite dies and disappears completely except some of its haustoria with their absorbing tissue, which remain embedded in the tissue of the host. The absorbing tissue becomes gradually isolated from the parasite on its death and decay, remains alive, though inactive, during the summer. Its requirements are well supplied by the host through the intimate connection of the xylem and phlœm of the host and the parasite.[3] Early in next rainy season, stimulated by the renewed activity of the host, these isolated absorbing tissues "Islands" embedded in the body of the host, organise several centres of growth, each of them will ultimately produce an young shoot or stem. Thus, number of young shoots are formed and they push themselves out of the cortex of the host. Further growth of these shoots results in the fresh attack of the uninfected parts of the host.

This method of perennation of *Cuscuta reflexa* appears to be an adaptation to the ecological conditions under which it is obliged to grow. *Cuscuta reflexa* cannot possibly continue its vegetative growth throughout the year like the above mentioned *Cuscuta verrucosa*, for reasons of marked variations in climatic conditions. Further difficulty is also felt by the parasite to propagate effectively, by means of seeds specially in the absence of proper hosts at proper stages of development in the immediate neighbourhood of the seedlings. It is essential to note in connection with the above that *Strobilanthus* occurs gregariously in vast numbers forming almost the sole undergrowth in forests which does not support another lower strata of vegetation, to serve as hosts for the seedlings of *Cuscuta*.[4]

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March 23, 1937.

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[1] J. D. Hooker, *Flora of British India*, **4.**

[2] Oliver and Kerner, *Natural History of Plants* (Eng. Ed.), **1**, 171–76.

[3] G. J. Peirce, *Ann. Bot.*, **7**, 291–318.

[4] J. C. Willis, *A Dictionary of Flowering Plants and Ferns*, 1925, 194–95.

Current Science Vol. 5, no. 10, Apr.

The Inheritance of Deciduousness of the Pedicelled Spikelets of Sorghum.

THE occurrence and inheritance of deciduousness in the grain bearing sessile spikelets of sorghum has been recently reported.[1] Pedicelled spikelets are a constant feature in sorghum earheads. They occur along with sessile spikelets singly and in two's at the terminals of the racemes. These pedicelled spikelets are usually abortive. The terminal ones may occasionally be antheriferous. The anthesis of these antheriferous flowers has been noted.[2] Pedicelled spikelets occasionally turn hermaphrodite.[3]

Pedicelled spikelets differ in their size, prominence and the length of their pedicels. In wild sorghums they are always deciduous. In cultivated sorghums they are usually persistent, though in some varieties they are deciduous (*vide* illustration). This character of deciduousness has proved to be of taxonomic value. As in the case of deciduous sessile spikelets, the pedicelled ones also, when deciduous, fall off breaking at the point of articulation of the spikelets with the tip of the pedicels, leaving conspicuous discoid white tips at the ends of the pedicels.

This significant character has proved heritable. *Sorghum margaritiferum*, Stapf. a variety of sorghum from Sierra Leone is characterised by deciduous pedicelled spikelets. In crosses between *Sorghum margaritiferum* Stapf. and the grain sorghum, *Peria*

manjal cholam (*Sorghum Durra*, Stapf.) var. *Coimbatoricum* (Burkill) Snowden (with persistent pedicelled spikelets), the first generation plants had persistent pedicelled spikelets.

Persistent Deciduous

Pedicelled Spikelets in Sorghum.

In the second generation there was a simple monogenic segregation between persistent and deciduous spikelets. The figures are as follows :

F_2 Family Nos.	Pedicelled spikelets	
	Persistent	Deciduous
A. S. 4746, 4747, 4772, 4773, 4973.	293	88
$X^2 = \cdot 7$	$P > \cdot 05$	

From this a third generation of 19 families was raised and of these 3 families bred true to deciduousness, 4 to persistence and 12 segregated again as follows :

F_3 Family Nos.	Pedicelled spikelets	
	Persistent	Deciduous
A. S. 4787, 4788, 4790, 4791, 4794, 4795, 4796, 4797, 4799, 4800, 4802, 4803.	438	136
$X^2 = \cdot 05$	$P > \cdot 05$	

A similar experience has been met with in another race of sorghum from Nigeria, *Sorghum caudatum*, Stapf. In family No. A.S. 4946 there was a segregation for this character, there being 67 earheads with persistent pedicelled spikelets and 22 with deciduous ones.

It will thus be noticed that the deciduous character has proved a simple recessive to persistence. The gene responsible for deciduousness of pedicelled spikelets has been designated sh_1. Sh_1 results in the persistence of pedicelled spikelets. Sh_1 is a simple dominant to sh_1.

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March 19, 1937.

[1] *Curr. Sci.*, **4**, (6), 299.
[2] *Ind. J. Agric. Sci.*, **1**, (IV), 453.
[3] *Curr. Sci.*, **3**, (9), 433.

REVIEWS.

Chemists, Lives and Works. By S. V. Divekar. (Standard Publishing Company, Bombay), 1936. Pp. xii + 298.

This book has been written ostensibly to help the candidates for the B.Sc. examination of the Bombay University. It gives the life and work of thirty-one famous chemists and covers a period of nearly a century and a half. The first chemist studied is Sir Henry Cavendish who flourished from 1731-1810. The youngest of the chemists studied is Henry Gwyn Jeffreys Moseley, the discoverer of atomic numbers, who met his premature end in his twenty-eighth year in 1915, while in active service in the Great War. The book includes also the lives of two living chemists—Richard Willstätter, familiarly known as the "Chlorophyll Wizard" and Sir Prafulla Chandra Ray, our distinguished countryman, who has been called the "Master of Nitrites" by Prof. Armstrong.

One chapter is devoted to each of the thirty-one chemists studied in the book. Each chapter begins with a portrait of the chemist. Then we have, on an average, a three-page chronicle of the chief events of his life. Then follow three more pages into which has been condensed a fairly exhaustive treatment of his chief contributions to Chemistry. The result is that we get a biographical picture of the eventful period commencing with 1784—when Cavendish published his studies of the properties of hydrogen and the composition of water in his paper entitled "Experiments on air" in the *Philosophical Transactions of the Royal Society*—and ending with 1929—when Jun Perkin laboured at synthesising dicentrine and narcotine.

A good deal of labour should have been spent in collecting the rich data scattered throughout the book. The educational value of the book would have been considerably enhanced if a short bibliography of sources had been added at the end of each life, with exact page references. A book written for B.Sc. students should aim not only at imparting information but also at leading the students on to the use of the original sources. It is the latter aim that is really more productive and valuable. No doubt, names of fifteen books and three journals occur under the heading "Bibliography" in a fly-leaf at the end of the book. But that is not the kind of bibliography that will stimulate the youth to further work. After all, the author should have had the exact references in his hands. Hence, it is desirable that they should be made available to the students, at least in the next edition, in the form I have mentioned.

S. R. RANGANATHAN.

Methods of Chemical Control for Cane Sugar Factories and Gur Refineries. Adopted by the Sugar Technologists' Association of India, Second Edition. (Published by the Sugar Technologists' Association of India, Nawabganj, Cawnpore, India), 1936. Pp. xiii+387. Price Rs. 10.

This book has been published by the Sugar Technologists' Association of India and is a compilation of all their approved methods of chemical control, according to a scheme drawn up by Noel Deerr. Unlike a mere compilation the book contains explanations of the principles and apparatus employed in sugar factory control.

It is divided into two parts. The first part is descriptive of the approved methods and the second part merely contains 32 useful tables and control-data sheets.

The book commences with a set of definitions approved by the Association and the Java Hawaiian definitions are included for comparison. The fundamental formulæ for factory control are derived in Chapter II and there the recommendation is made that "Sucrose" values should be made the basis of control in preference to "polarisation" figures. In the chapter on the control of the factory are included both the mill and boiling house control. The former is amply illustrated by typical Brix-variation curves.

The important and up-to-date methods for determining water, solids, fibre and sugar form the subject of two chapters and the principles, apparatus and procedure are fully explained with illustrations.

(*Continued on page* 551)

SUPPLEMENT TO

CURRENT SCIENCE

Vol. V April 1937 No. 10

The Problem of Reality in Physics.*

By Professor R. Ortvay, *Budapest.*

1. The Present Crisis in Science.

NOWADAYS we often hear the assertion that science is passing through a crisis. Popular works and newspapers speak of a "Bankruptcy" of science, and even some excellent representatives of science express the opinion that science is developing in a wrong direction. Others declare that the very aim of science, namely, the search for truth, is wrong, or, at least, fruitless; they only attribute a value to purposes of immediate utility. Others, again, fix their attention upon the radical change of the circumstances of life under the influence of technical sciences, and, regarding the numerous effects of industrialisation which have destroyed the equilibrium of social forces, often arrive at sceptical conclusions. And one of the strictest critics of our civilisation, the recently deceased Oswald Spengler, is, according to his great work *Decline of Western Civilization*, inclined to detect certain signs of decadence in some of the most glorious achievements of modern science.

While we cannot deny that there exists a crisis in our civilisation, manifesting itself in political and social restlessness, we also cannot doubt that in science, too, there is a certain crisis. This may give a justification for devoting a few words to the nature and importance of this crisis.

Many of you may be inclined to reject at once any doubt about the value of science. And I think, to the same group would belong everybody who has merely objectively witnessed the scientific development during the last decades, as well as the majority of those who take part in scientific movements. Science has passed from one triumph to another, succeeded in observing an immense multitude of facts and in explaining them from a unitary point of view; thus we are fully justified in calling the present time a golden age of science. And, if we consider the innumerable effects of science on practical life, the part steam and electricity play in it, or even the most recent inventions such as broadcasting, the applications of various radiations, aerial traffic, and so on, we likewise arrive at the conclusion that something causing such effects must certainly possess a deep-rooted intrinsic importance. For, even if we do not agree that the value

* From a lecture delivered at the Indian Institute of Science, Bangalore, on 6th January 1937.

of science is given by its practical availability, we must acknowledge that practical effects are, though rather external, yet the more easily discernible signs of its importance.

On the other hand, science has undoubtedly undergone a very profound transformation in recent years. Many principles which were until recently regarded as incontestable axioms have lost this importance, and this can of course produce in a superficial eyewitness a feeling of uncertainty. Many excellent investigators who contributed fundamental discoveries to this transformation a few decades ago were unable to follow the further development and are now inclined to condemn it.

If, however, we examine the development of physics more attentively, we gain the conviction that the recent turn was entirely healthy and logical, without any sign of deviation or partiality, although the transformation of our ideas was very deep and we had to renounce many of them which formerly seemed evident. First of all we must emphasise that the whole development was continuous and smooth. Although it took a formidable pace during the last decades, we can say that the great discoveries followed one upon another continuously since the renaissance and particularly during the past century. We can even assert that the latest transformations, the atomic and electronic theory, the theory of relativity and the quantum theory, developed very smoothly, without deeper controversies, as if with a general consent. Struggles such as *e.g.* accompanying the Darwin theory of descent did not arise and it did not come, to the formation of great antagonistic schools. There was, of course, some contradiction, but partly of sheer outsiders and partly of physicists, who, although some of them had great merits as experimenters, were not sufficiently familiar with the language of mathematics which is so indispensable for expressing and understanding the physical contents of the new theories. All these controversies, although assuming sometimes, particularly in the case of the theory of relativity, rather grotesque forms, had only an insignificant influence on the development of science; among those possessing the necessary command of mathematics there was hardly any opposition and the foundations of the new theories now appear obvious facts in general opinion.

The theory of relativity presented itself immediately in a perfect shape, as the climax of a long evolution. The development of the quantum theory, however, was quite different. This fundamental theory of modern physics emerged as a very special hypothesis which could not be fitted into the frame of classical physics, and it grew after a long struggle to the present general theory. If leads to a modification of classical physics which is even greater than that effected by the theory of relativity, it demands a radical change in anciently-rooted ideas and presents a great number of unsolved problems. But, it has finally opened new domains and interpreted such important phenomena (I refer only to the theory of spectra and to the waves of matter), that its elimination from physics is impossible.

The continuity in the development of physics shows that the new great theories actually include the old ones; they acknowledge the validity of classical physics within the realms of observation it was meant to explain.

It follows that there is nothing in the development of physics to weaken our confidence in the healthy state of science. On the other hand, we notice that actually there is succh a distrust as a social phenomenon of to-day. Perhaps it is so because of the long continuance of the rapid development of science in a particular direction which, possibly, is not quite free from a certain onesidedness. Perhaps people are feeling that it is high time for other components of our civilisation to keep pace with the development of the exact sciences. Perhaps the effect produced by science upon the forms of life, the transformations in the production of goods, the modifications in the structure of human society are taking place too rapidly to ensue in harmony; this results in phenomena which certainly can be called critical. The problem of how to eliminate social and economic disharmony, however, cannot be solved by stopping the development of science; it must be solved, on the contrary, by the methods of science

themselves. Slogans such as "stop science" and similar demagogic anti-scientific catch words which we can hear nowadays in certain countries with a glorious scientific past, certainly can cause heavy damage to the development of science ; such slogans are, however, not produced by the evolution itself of science but are mere symptoms of the general crisis of our civilisation.

Whilst we have thus to reject most decidedly any superficial and harmful assertion concerning the bankruptcy of science, we cannot deny that we have to face serious problems with regard to the effects of scientific development upon life as well as to its philosophical interpretation.

This lecture is intended to give the presentation of a problem of the scientific interpretation of the world. I hope to make a contribution to the solution of this problem which is the problem of *reality* in physics, the question what is to be regarded as *real* in natural sciences. Just in these days there is an ardent polemic on this matter between "positivists" and "realists"—a polemic which, of course, does not touch the existence and the foundations of science.

2. The Notion of Reality in Common Life and in Philosophy.

As long as we take a naive, uncritical standpoint with respect to the contents of our consciousness, the problem of reality does not present itself. In this stage everything occurring in consciousness appears as real; objects and sounds, dreams and fancies. The problem of reality first emerges when, in order to acquire a unitary scientific view of the world, we begin to distinguish between essential and unessential, between permanent and transient, between "real" and "apparent". These categories are correlative and appear always simultaneously. We shall consider a few examples taken from common life in order to fix the meaning we want to attribute to these words.

If my house burns down or a friend dies, these events will have portentous consequences upon my whole life ; they will greatly influence the future contents of my consciousness. If, on the other hand, these events occur in my dreams only, they will have no such consequences ; I shall dwell in my house as before and I shall continue to meet my friend. The two cases are quite differently related to other events of my life : the first is of serious consequence, the second remains an isolated event scarcely related to others. When we say that a political movement has a reality, whilst another lacks reality, then we understand that the former cannot be ignored without risking serious consequences, whilst the latter can be left out of consideration without incurring a risk.

When a solid body runs against me, it will hit me and possibly hurt me. On the contrary, a shadow running against me and falling on my body will have no serious consequences. When I plunge a rod into water, it will appear angular ; after removing it out of the water, it is straight again. In other cases, when a rod appears angular, it cannot be used again and will soon fall into pieces. We cannot seize a *fata morgana* or a rainbow; these do not behave as real bodies.

These examples show how we discern in common life between real and apparent, or even between different degrees of reality. We see that it is the importance or the effectiveness which serves as a measure of reality, which is thus fixed by a judgment of valuation. It is often the mere persistence in time which forces us always to reckon with a certain thing and which consequently serves as a criterion of reality.

In philosophy the notion of reality has a similar meaning.

We remember the famous simile in Plato's dialogue on the "State"; here the perceptions are compared to shadows of bodies projected on a wall by a fire behind the spectator, bodies being in movement in front of the fire. The shadows represent the realm of the "apparent", the bodies moving in front of the fire those of the "real" beings ; the simile has to explain that the objects as they appear to our senses belong to the realm of the apparent, whilst the eternal and unchanging "ideas" are representations of the sphere of the real. In Indian philosophy also, real and apparent are contrasted in a striking manner. Thus in Vedanta philosophy the world of *Maya* as the realm of the apparent, of illusion, contrasts with *Brahman*, the

unchanging, eternal, perfect, solely real being, the only existence which really deserves this expression.

In Buddhist scripture the things of the world are compared to "foam floating upon the Ganges" to "the *pisang* which lacks a solid framework", to a *fata morgana*, to a "bubble of water"; they are transient and unimportant. Contrasting with them there exists something defined by negative attributes only: the *Nirvaṇa*, which, with all its negativity, plays exactly the same part as, in other systems, the highest degree of reality, the absolute reality or the Deity.

3. Realism and Nominalism.

In philosophy, a fundamental problem of any system is to determine what is to be regarded as real. Likewise, in the exact sciences the same problem is always present and passes through their history, as we shall see later. Here we shall mention two antagonistic points of view, the struggle of which runs through the entire history of philosophy and, in a modified form, can be found in physical discussions upon the question of reality. These antagonists are *realism* and *nominalism*. The idea of realism, that is, of philosophical realism, first emerged when people became conscious of the existence of abstract ideas, and recognized their importance. To-day we can hardly imagine how astonishing and admirable this perception must have been; the long-searched for Absolute Reality was thought to be found in abstract ideas. Thus, when Pythagoras began to have a present time of the actual importance of numbers, he thought them to be the true fundamental reality and made of them an object of almost religious worship. And Plato perceived Ideas as the really existent things, in contrast with the transient, alterable bodies given by sensuous perception; he founded a system of philosophy which, in a way is still existing.

The question concerning the nature and importance of ideas has since then always been on the programme of philosophy.

Opposing this realistic standpoint of Plato, there is another point of view, according to which there is no reality beyond the transient, alterable sensuous things; notions are mere names. Hence this standpoint is called "nominalism". These points of view are fighting one against another in the ideas upon the foundations of modern physics.

4. Positivism.

In the philosophy of to-day, nominalism appears in a characteristic form in the direction of epistemology which was started by the works of Ernst Mach, the Vienna physicist and philosopher, in the closest connection with the problem of the natural sciences and particularly of physics, and has become almost an official philosophy of the quantum theory of to-day. Phillip Frank is one of those who have worked out this program in detail. But also the great representatives of the quantum theory, Bohr, Heisenberg, Dirac and Schrödinger, share this way of thinking; Jordan has recently given a very clear and unexaggerated presentation of it in his newly published book. On the other hand, Planck, Laue and Sommerfeld are the chief representatives of the realistic point of view in physics.

According to Mach, our only direct data available are the sensations. Any other thing is composed of them; it is but a complex of sensations, either simultaneous or not. So are our notions, our logical functions such as judgment and so on. There is no physical reality independent of sensations; the postulate of such an independent reality is a mere logical construction which serves to express connections between our sensations, to foretell coming sensations. That my writing-desk is real, means only that some optical, haptical or thermal sensations by which its notion is defined always arise when circumstances are suitable, for example, when my eyes are opened, when a lamp is burning or when my hands are in a certain position. Beyond this nothing can be said and thus it is no problem at all but a meaningless question to ask whether the writing-desk exists when I am not observing it.

More generally, it has no sense at all to speak of the existence of a thing which cannot be observed; thus, *e.g.*, it is a senseless question whether other worlds exist

which are in no connection with our world. *Nothing exists that cannot be observed*: this is the view of positivism.

The recent positivism that has arisen from quantum mechanics is much less engaged in the analysis of sensations; it considers sensations rather as symbols which can completely be replaced by pointer-readings on instruments. They *should* even be replaced by pointer-readings for the sake of exactitude and unambiguity. This is obvious to the physicist; thus a certain colour can unequivocally be described from a physical point of view by a wave-length as the result of a diffraction experiment, unless we have to do with its bearing on physiology. According to this view the fundamental facts are pointer-readings or coincidences of a pointer and a point of the graduation; the problem is to find functional relations between different pointer-readings, to infer from certain pointer-readings other ones, occurring possibly in the future.

5. Analysis of Immediate Experience.

The common point of view, however, is quite different from this. Our attention is commonly directed to the things themselves instead of our sensations of them; in common life we neglect the accidentals adhering to our sensuous impressions. When we form an idea of a thing or a person, we do not imagine a certain perspective view of the object under a certain illumination, although our impressions always refer to such a particular picture; we think, on the contrary, of characteristic features that are common to all views of the object. The art of primitive nations deals, in the first place, with characteristic features of the object: the face is represented in profile, the eyes seen in front; it is a much later stage when a singular impression is brought into consciousness by a conscious spiritual effort. We try to pick out of the variable sensuous impressions a constant kernel on which, by preference, our attention is fixed; in common life we hardly care for the immediate pure sensuous impressions which only concern the psychologist in the moment he is at work. To fix the attention on the moon, or to be conscious of a yellowish circular optical impression, are quite different things; in the first case the yellowish circle is only a sign, a symbol of an object. This difference has, of course, nothing to do with the question whether I am, in an actual case, succumbing to an illusion or not. The elucidation of these things represents an important merit of the new psychology and phenomenology. In a similar manner, the properly so-called mental activities, judgments, and so on, cannot be derived from sensuous impressions and their succession; they are actually separated from them by a wide gap. If a physicist looks upon the sensuous impressions as the only ultimate elements, he accepts an entirely obsolete and incorrect psychology. Mach already has extended the circle of the immediately given elements by including the space-time structure of the world in it, and Jordan, in his above-mentioned excellent book, points out that certain "totality conditions", Ganzheitsbedingungen, must also be taken into consideration. Nevertheless, I think that positivistically-minded physicists do not recognise clearly enough how narrow and partial their picture of the immediately given elements of the world is. It would be very advantageous for them to learn to know some important psychological and phenomenological researches concerning the question of what is immediately given to us. The works of Husserl, Stumpf, Messer, Scheler are also accessible to physicists, though they may find some difficulties in the terms used by the philosophers. So far as I know H. Weyl is the only mathematician and physicist who is aware of these problems.

6. Physical Realism.

On the other hand, the state of mind of a physicist is much nearer to that of the common man than to the positivistic theory, as soon as he deals with a concrete physical problem, instead of the philosophy of physics. His interest is then directed, not to sensations or pointer-readings which play the rôle of mere tools, but to the objects themselves. In his paper entitled "Wege der Erkenntnis" Max Planck gives a very plastic expression to this point of view. Our theories refer to the moon, to liquids and solids, to atoms, molecules and electric fields, instead of direct sensual impressions. The fundamental task of physical research is just the construction

of a description of the world which is independent of our individuality and of limitations imposed by our organism. This, of course, can only be accomplished by a process of gradual development ; we acquire step by step pictures of more and more profound reality. We can see this very clearly in the development of astronomy. The Ptolemaic cosmology attaches itself immediately to the observations of the curiously slung paths of planets as they appear to a terrestrial observer. On the other hand, the Copernican theory renounces a direct reference of the observed data to the terrestrial observer ; it relates the planetary movements to the Sun and obtains thus very simple paths instead of the former complicated ones. By this simplification a path was opened to the establishment of fruitful hypotheses and the discovery of the laws of gravitation by Newton was made possible. Here the progress consisted of the choice of an invariant description instead of a description from the point of view of a particular observer. By this choice a mathematical description of the phenomena for any observer was rendered possible.

This process repeated itself much later in the theory of relativity and, in a more abstract form in the Dirac transformation theory of quantum mechanics.

The positivistic standpoint which endeavours to reduce everything to pointer-readings is, of course, not incorrect, as the facts can be described in this manner also ; it is, nevertheless, extremely partial and even incorrect as soon as it pretends to be the only possible expression of the absolute truth. A comprehensive theory cannot be built up if nothing but the elements from which we start are permitted to figure in it. Otherwise our way of proceeding would be analogous to an effort to remove abstract ideas. Indeed, we teach children by telling them that two apples *plus* three apples equal five apples ; two horses *plus* three horses equal five horses ; but as soon as the child has conceived the idea of the abstract numbers, further learning on concrete examples is unnecessary.

7. Nominalism and Realism in Physics.

The antagonism between positivism and physical realism is analogous to the relation between nominalism and philosophical realism. According to nominalism and also to positivism, the only directly given data are the sensuous impressions ; anything beyond them is a result of intellectual construction and is reducible to sensuous impressions. In opposition to this, realism attributes self-existent reality to notions and physical objects respectively. Here triviai contradictions result, of course if we do not discern sufficiently between physical objects and abstract notions. The notion of the number 3 does not float in the air between other things, nor exists in the time ; but it has its " place " in the row of integers, *viz.*, between the numbers 2 and 4. We often hear that abstract notions can be constructed arbitrarily, whilst physical objects are given things with fixed attributes. We want to examine this question more closely. We can term a thing a Three, a Four or a Multiplication ; by this, however, we only specify the notion we have in our mind, just as if we would state what physical object we intend to examine. After we have done so, we are no more free, *e.g.*, in prescribing what factors the number 6 may contain. The following arithmetical example may be useful with regard to the case of sensuous things and of physical objects also. An irrational number can be defined as the limit of certain sequences of rational numbers. Any proposition concerning irrational numbers can be interpreted as a proposition concerning such sequences ; a representative positivistic philosopher, Ph. Franck, even says that an irrational number is nothing but a name and is identical with the sequence which serves to define it. This statement is true in so far as any proposition can be described by referring to the sequence only. It would, however, be partial and even false, if we would regard it as the only possible expression of the facts. We can, indeed, define an irrational number by means of an equation of which it is a solution ; we can methodically deal with it on this basis as is done actually in the theory of algebraic numbers.

Quite similarly, we can express any relation between complex numbers as a relation between real numbers ; we can regard a complex number simply as a system of real numbers. But we can also consider complex numbers as self-existent quantities defined by the rules they are obeying.

Correspondingly, we can regard a matrix equation in quantum mechanics as a symbolic expression of a finite or infinite number of ordinary equations. But this is one possibility only. We can also consider the matrices as defined by their operational rules and admitting an infinity of representations by means of ordinary numbers, none of which possesses a higher degree of reality than the others. In his profound book, fascinating in its ingenious exposition also, Dirac speaks of the notions of quantum mechanics as follows:

"The new theories, if one looks apart from their mathematical setting, are built up from physical concepts which cannot be explained in terms of things previously known to the student, which cannot even be explained adequately in words at all. Like the fundamental concepts (*e.g.*, proximity, identity) which every one must learn on his arrival into the world, the newer concepts of physics can be mastered only by long familiarity with their properties and uses."

The fundamental quantities of quantum mechanics, the operators, are so far from our familiar notions that we cannot wonder at the acuteness with which the question of physical reality was reopened by the quantum mechanics.

8. The Relativity of the Logical Basis.

The above-mentioned examples from arithmetic (irrational and complex numbers, matrices) show that we can regard the same fact from many points of view, which are not at all in contradiction one to another. I think this fact leads to an adequate judgment of the relation between realism and nominalism, as well as between physical realism and positivism. In a logical system it is to a certain degree arbitrary what is to be considered as belonging to the basis of the system and what as a deduction. Thus we can build up geometry with many systems of axioms which we can choose differently among the propositions, just as we can represent a vector by means of different systems of fundamental vectors.

In my opinion, the same applies to the question concerning the mutual relation of nominalism and realism and the relation between direct sensuous experience and intellectually constructed physical reality. The characteristic feature of positivism is that according to it anything which is not directly observed possesses but a lower degree of importance. In connection with this, we must remark however, that the question of what is to be considered as immediate sensuous experience is not at all so simple and unambiguous as a naive psychology might suppose. We must bear in mind that things are arranged in a space-time order and that the nature of this order is an ancient problem of philosophy. In my view, the space-time order of the things is already the result of an elementary intellectual treatment of the raw material given by pure experience; we can call it a "natural" theory of the world. Positivism or nominalism and realism are two possible standpoints differing in the choice of the elements used for constructing a description of the world. They are both as well justified as the cosmologies of Ptolemy and Copernicus which differ only in the choice of the system of co-ordinates. We must be careful, however, not to believe that all similar philosophical and epistemological systems are true in every respect. We must, on the contrary, judge each case on its own merits, supposing that a conclusive judgment is possible at all at the present state of our knowledge.

9. Changes of the Notion of Physical Reality.

The history of physics offers numerous examples for the diversity of the ideas which at different times, served as fundaments for the description of the physical world.

Thus, in the infancy of physics, when it was not yet separated from philosophy, the central rôle was played by the doctrine of the four elements; fire, air, water and earth. To-day, in the possession of the idea of the chemical element, one is, in the first moment, inclined to smile at this naive conception. But looking more deeply into the matter, we see that the doctrine was quite adequate to the general level of those times. It contains, essentially, the most common representatives of the three states of matter and, besides, fire as the representative of temperature, the idea of which was not yet worked out clearly enough at that time. The view that all bodies result

from a suitable composition of those four elements is likewise not to be interpreted in the strict quantitative manner of modern chemistry ; it means only that the state of all bodies can be expressed by means of those four "elements". The doctrine of the four elements appears thus as a primitive but by no means foolish attempt at systematising the reality. It only becomes absurd and senseless if looked upon from the present quantitative standpoint of science.

Another example is given by the cosmologies of Ptolemy and Copernicus which we have just discussed.

A particularly instructive example of changes in the idea of physical reality is offered by electromagnetism. In the classical theory of electricity and magnetism the fundamental laws refer to charges and poles, the forces acting between them being given by the well-known Coulomb laws. In this system electric and magnetic fields are of secondary importance. Energy and potential appear as important auxiliary notions which serve for expressing properties of systems of charges ; their physical reality, however, is of a lower degree than that of the charges ; they possess no substantiality.

The electromagnetic field and the energy appear, then, as fundamental notions and even as substances in Maxwell's electrodynamics. Here the field is not a mere auxiliary construction, determined by the distribution and motion of the charges in a certain moment ; with Maxwell, the field is a self-existing entity and the charges are, in a certain sense, degraded to mere singularities of the field, to places where the lines of force join one another, the divergence being there different from zero. Energy, on the other hand, is localised and possesses a mass. Thus the view expressed first, though in a somewhat vague manner, by W. Ostwald, according to which energy is to be considered as the fundamental substance, was realized in a concrete form in electrodynamics and in Einstein's theory of relativity, representing a foundation-stone of our present conception of physics. (We can, of course, interpret the equations of Maxwell by referring them directly to electrical charges ; this would, however, be rather forced.)

A more recent example is given by the quantum theory of the electromagnetic field. It was known for long that a given electromagnetic field can be developed into a Fourier series. But it was the quantum mechanics which attributed a self-existent importance to the individual terms of this Fourier series, considering them as a sort of co-ordinates and submitting them to the procedure of quantization. This idea of Dirac has then been applied to the case of waves of matter (Jordan and Wigner).

The criterian of reality suffered a thorough alteration in quantum mechanics and this process has, perhaps, not yete ome to an end. With regard to this matter, I shall limit myself to a few hints. In the first place it turned out that the fundamental notions of classical mechanics such as the momentum, energy, etc., are to be replaced by certain operators which lead to the possible values of the corresponding quantities as they can be measured by observations. The mutual relations of the dynamical variables are also to be replaced by relations between the corresponding operators. These new relations, however, are generally not identical with the corresponding classical relations. The notion of the state of a system has also undergone incisive alterations as compared with the classical way of thinking. It turned out that in contrast to classical mechanics, we cannot attribute numerically determined values to all variables of a system simultaneously. Thus, *e.g.*, we cannot determine simultaneously both the position and the velocity of an electron. Since we can, according to the positivistic view, only speak of quantities which can actually be measured, we must say that in a given state of a system certain mechanical variables (*e.g.*, the position of an electron, the velocity of which has previously been determined exactly) actually have no sharply defined values at all. If we make a measurement which leads to a defined value of such a quantity, then we must admit that after the measurement the system is no more in the state which existed before the measurement, since in this state the measured quantity had no value at all.

If, however, the measurement refers to a quantity which has been measured immediately before, then the repetition must lead to exactly the same value. By this fact, I think, we are entitled to attribute to a state the same objective existence

as in the classical theory; the change would only refer to the manner in which the state is defined. We often hear the opinion that we cannot attribute objective characteristics to a system, since the data describing it depend on the results of measurements. This view, however, is not correct. We need a certain measurement in order to bring the system into a defined state; after this is done, any further measurement which refers to the same quantity and thus does not alter the state of the system, leads to the same result.

We can also describe a state in the following manner. A certain measurement may have previously been performed which leaves the system in a state in which a certain quantity other than the measured one (the so-called "conjugate" quantity) has no defined value at all. Then the state is completely described if we know the probability of any possible result of a measurement of this second quantity. These probabilities are given by the solutions of the Schrödinger equation. The ψ of Schrödinger, the wave function, describes the state of a system by relating it to a given ground state. For example, if the state of a hydrogen atom is given by fixed values of the energy, of the absolute value of the angular momentum and of a component of the latter, then $|\psi|^2 dV$ gives the probability of finding the electron in a space element dV. This we must understand in the following manner. The measurement of the position of the electron is, in the sense explained above, incompatible with an exact measurement of the energy or momentum. In consequence of this, we destroy the state with a fixed energy and angular momentum by measuring the position, we then obtain a new state with a determined position but undetermined energy and momentum. The probability of obtaining a given position by measuring it in a system with given energy and momentum is then determined by Schrödinger's equation.

10. Summary.—The Value of Positivism.

The essential contents of our exposition may be summarised by saying that positivism and realism, and nominalism and realism respectively are both admissible points of view if they are carried through correctly; they only differ in their starting-points. Positivism, in the form which was developed under the influence of quantum mechanics, leads to a profound change of our idea of the physical state of a system. In my opinion, however, it does not destroy the notion of the objectivity of a state; it merely claims that, for defining a state, certain necessary measurements must have been performed. By this demand the objective existence of a state is not affected, just as the objectivity of space is not affected by the fact that when I say that a star is at the zenith, I must add the geographical position and the time the zenith is referred to.

On the other hand, I must object to the psychological doctrines concerning immediate experience as they are used in the physical literature of to-day. Similarly, I cannot agree with certain exaggerated positivistic statements, as for example with the identification of observability and existence.

In connection with this, I may return briefly to a frequently heard example of a statement which is meaningless in the positivistic sense, namely, to the possible hypothesis that a world may exist which has no connection with our world. Such a hypothesis could, of course, not be tested by observation. But we can imagine the case that the masses in the world gradually accumulate at two different places and thus the world divides into two separate parts. After this process is completed, two worlds exist which are possibly without any connection.

There is an analogy between this example and the problem of the psychological accessibility of strange persons. The feelings or impressions of other people are entirely inaccessible to a direct observation; for example, I do not know whether the impression my friend has at seeing a certain colour is the same as my own impression or not. Here we can help ourselves with analogies only. And now I think we are on the wrong path if we infer that the existence of my friend consists merely of my having certain sensuous impressions of him.

Finally, there are parts of the world which I never can observe and yet I must suppose them as existing. I speak of the

state of the world after my death. I can feel deeply concerned at the development of politics or of science after my death, although these things cannot be observed by me.

In the book which we have mentioned already, Jordan claims that it is the life of the human race instead of the individual life to which all similar problems must be related. In this case, however, we must decide to acknowledge an existence which transcends the circle of our own experience, namely, the existence of other persons which is more than a mere part of our own individual experience. I think that in doing so the dogmatic positivism falls to pieces. There survives, however, in any case the important work performed by positivism in eliminating many meaningless questions, and there survives the profound modification by the quantum mechanics of our idea of the physical state.

I think that the idea of physical reality needs a long development to appear at last in complete clarity and that this development has been strongly advanced by positivism. On the other hand, quantum mechanics most probably cannot be considered as the final stage of this development. Quantum electrodynamics and the problem of the elementary corpuscles even point at profound gaps which are yet to be filled.

Man is inclined to consider the stage he has just arrived at as the revelation of the absolute final truth; this illusion is almost a matter of course. It is good therefore to remember Newton's words:

"I do not know what I may appear to the world, to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."*

* D. Brewster, *Life of Newton*, p. 338.

For determination of reducing sugars the Association recommends the Munson-Walker and Eynon-Lane methods. Sulphate ash without the 10 per cent. correction is preferred to the carbonate ash and the conductivity method is described.

The subjects of pH control and polarimeter are dealt with in two chapters which are specially well written. A description of fuel control and recording instruments and the colour comparison of sugars are given in two chapters which are indeed very useful additions. The control of Gur Refinery is rather meagerly treated and is disposed of in less than two pages.

This publication is claimed to be the second edition of a work published in 1928 but it cannot be denied that this has entirely superseded its forerunner, in subject-matter and scope. The book has been wholly recast and is made to include references to standard publications. It is not intended to be a treatise on "chemical control" and therefore does not contain a discussion of the numerous methods in literature but the recommended methods are quite up-to-date and have been introduced with a full knowledge of similar methods adopted in other leading sugar countries and also the recommendations of the International Committee.

The publication of this book, at a time when standardisation and uniformity in the control of Indian factories are badly lacking is quite opportune and there is no doubt that our factories will increasingly adopt the methods recommended in it. The scope and treatment of the subject-matter are by no means restricted to Indian conditions. While the book becomes a necessary adjunct of every Indian Sugar Laboratory it will certainly be a very useful reference work abroad.

G. G. Rao.

Commercial A.C. Measurements. By G. W. Stubbings. (Chapman and Hall, Ltd., London), 1937. Second Edition Revised. Pp. 348, 169 illustrations. Price 15*sh.* net.

This book of ten chapters and an appendix, deals with the theory and practice of the measurement of current voltage, power, energy and power-factor in A.C. currents and is of great value to testing Engineers of all grades in the factory and on inspection work. The major part of each chapter consists of the presentation of experiments together with the discussion of the associated theory and phenomena.

The first two chapters explain the fundamental theory of alternating current and measurements, three phase systems, harmonic analysis and are illustrated with general equations and typical vector diagrams for connections of various types of instruments.

In the next two chapters, the methods of measurement of current, voltage and power are discussed with illustrations explaining the construction and use of various types of apparatus including the A.C. Potentiometer. The chapter on power and its measurement is comprehensive in dealing with the various standard methods and the apparatus used for the purpose.

The next chapter explains the theory of instrument transformers and their test and application. The following four chapters concern the measurement of energy, power-factor and re-active volt amperes and the use of various types of instruments and apparatus illustrated with diagrams. The last chapter is devoted to test room apparatus and the general design and equipment of a Testing Laboratory. The latest types of apparatus including the oscillograph and the harmonic analyser are thoroughly discussed.

The useful references to other published literature at the end of every chapter facilitates collateral reading and the treatise is to be classed as one of the standard books on Electrical Technology.

R. P.

Mathematical Snack Bar. By Norman Alliston. (Published by W. Heffer and Sons Ltd., Cambridge), 1937. Pp. 155. Price 7*sh.* 6*d.*

The volume may well be described as a collection of mathematical tit-bits, comprising certain Pythagorean, Diophantine and allied problems. The few rather apologetical remarks made by the author in his preface leave little room for any further or lengthy comment. To the great delight of the reader many problems in this "Snack Bar" smack of old acquaintances; he finds here solutions of many problems, which had once baffled him or which he had already solved in a similar if not the same way. The happy language which runs through the pages unfolding mathematical truths and surprises (such as "a straight line is the longest distance between two

points "), is not without its own surprises of word combinations. Mention must also be made of the choice of names like " gravity point " for " centre of gravity ", " ad-circle " for " ex-circle ". The book stimulates an amateur to mathematical pursuits; even the specialist would find it interesting reading. It may usefully be acquired by libraries of junior colleges. B. S. S.

Analyse des Matieres Crystallisees au Moyen des Rayons X. By M. E. Nahamias. (Actualites Scientifiques et Industrielles, Hermann and Cie., Paris.) Pp. 332. Price 15 *francs*.

In recent years X-ray diffraction methods have been employed for purposes of identification and analysis of crystalline materials. The potentialities of the X-ray method for these purposes are very well brought out in the above monograph, the author of which has himself made many valuable contributions to the subject. A very clear description of the various methods of work are given in lucid style and it is hoped that the monograph will be welcomed both by mineralogists and analytical chemists. In Chapter II methods are set forth in full detail for quantitative determination of the crystalline constituents of a mixture. The monograph is well illustrated by X-ray powder photographs of various minerals.

S. R. S.

'Saltation in Fungi.' By Dr. S. N. Das Gupta. (Lucknow University Studies, No. 5. Edited by Prof. B. Sahni, Sc.D., F.R.S.).

This little volume forms the fifth publication of Lucknow University Studies, and is based on a course of three lectures on Saltation and Related Phenomena in Fungi delivered by Dr. Das Gupta at the Lucknow University during the session 1934-35.

Though a large amount of work has been done in this field, Dr. Das Gupta rightly points out that our knowledge regarding saltation is meagre and that the facts that are before us do not allow of any generalisation. The term 'saltation' (sometimes also called mutation or sport) is used when a new strain is formed from an apparently pure strain of fungus, and it indicates that in some hyphæ of the parent mycelium the genetic constitution of one or more cells had undergone a definite change due to either morphological or physiological factor or both. The papers on different types of saltations and induced saltations and the difference between the parent and saltants regarding the morphological, physiological and parasitic activity have been discussed and presented in a very readable form. In the last chapter of this little volume references have been made to bud-variation and plant-chimæras in higher plants which are comparable to saltation in fungi and the production of 'Mixochimæras' in *Phycomyces nitens* and in *Botrytis* has been referred to.

Dr. Das Gupta has given us a concise account of the available facts relating to various aspects of saltation up to 1934 and his references to over 150 original papers on this subject will be very useful to the workers in the field. H. C.

An Outline of Indian Temple Architecture. By F. H. Gravely, D.Sc., F.A.S.B., Superintendent, Madras Government Museum, Madras. (Government Press, Madras.) Price As. 12.

The Madras Government Museum has been long famous for its *Bulletin*, first issued by the late Dr. E. Thurston, who was known for his versatility. The new series now being published under the Editorship of Dr. Gravely, maintain the high level of scholarship, which marked the earlier numbers and are accordingly to be welcomed in circles interested in humanistic studies. The present number forms Part II of Volume III of the General Section of the New Series and is devoted to a topic that is bound to appeal to a large class of students. Temple architecture has been a subject of great interest from early days in India. Fergusson, who made the modern world know of the rich architectural and sculptural treasures of this country, was a poineer in this line of study. His writings possess a unique value even to-day and his descriptions, brief, succinct and apposite, are characterised by a charm and subtlety that defy definition. His theories invited adverse criticism even in his own days, notably from Ram Raz, the first Chief Justice of the Mysore Huzur Adalat Court, when it was constituted in 1832. Fergusson wrote at a time when Oriental studies had not yet been developed on any large scale and he was, besides, ignorant of Sanskrit and of the works bearing on Hindu architecture. But he was a genius and did much to popularise the scientific study of Indian

Antiquities, for which the people of this country will be ever beholden to him.

Few will quarrel with Dr. Gravely when he suggests that the division of Indian Architecture into Buddhist, Jain and Hindu is not strictly correct as all their beginnings can be traced to the original Hindu style. But when he seeks to make out that Fergusson's "separation" was meant to meet anything more than a mere differentiation for purposes of practical study, he seems to be unconsciously doing injustice to that great authority on architecture. Fergusson knew too much of Indian Architecture to be guilty of such an obvious mistake. It has been truly said of him that he invested the historical study of Architecture, particularly Indian Architecture, with a new interest. Nor is Dr. Gravely on a safe ground when he throws out the hint that temples may be classified under the heads of "Tamil", "Kanarese", etc., on the basis of what may be called "linguistic" and "territorial" areas, as these areas have changed from time to time owing to historical causes. Nor are differentiating phrases like the "Northern form" and the "Southern form" any more happy. The complexities of the problem discussed by Dr. Gravely are only increased by the use of phrases and terms of this kind and the classification of ideas he so much desires is not likely to be attained by their use in this connection. The fundamental point to grasp is that we should first know the theory as such of temple construction and from it proceed to the study of the actual examples available to us in the country and build up our history of temple architecture from it. Such a study as this is not only laborious, but also envisages qualifications in research students which may not be found available in one and all who seek to approach this subject. But that only shows how our equipment has to be improved and made suitable for the objective aimed at. Otherwise, we are bound to meet with phrases like "Temple of southern form, Tamilian style", etc., which suggest ideas which cannot but be characterised as having a half linguistic and half territorial basis. The attempt to study temple architecture and temples without any idea of the theoretic basis on which they have been built is doomed to failure. You can study temples, as Fergusson indeed did, from an *a priori* point of view and with the aid of traditional history fix up, as he did, their age. With the knowledge thus derived, classify the styles, as he did, from a territorial and a semi-historical standpoint. The other way to study them would be to learn the underlying original theory, and try to see how the actual examples left to us have proceeded in the hands of builders, noting the divergences as you go on. The influences—foreign and other—would thus be traced to their native sources and the data arrived at would enable one to draw up a classification on what might be termed a scientific basis. Any other method would not prove satisfactory for the simple reason that it would lack the foundations for a sure study of the subject. Is the term "Dravidian" Ethnic, territorial or linguistic in its significance? Dr. Gravely himself complains that Dr. Jouveau-Dubreuil has, in *Archéologie du Sud l' Inde* has restricted the "meaning of the term Dravidian". What we say is that he cannot but so complain in the circumstances we have detailed above. His suggestion that we should use the word—"Dravida" in connection with architecture and not "Dravidian" is no improvement, in our opinion, as it equally connotes both a linguistic and territorial idea, if not also an Ethnic one. The difficulty is inherent in studies of this kind which do not proceed from connected knowledge of the theoretic basis on which they actually stand. The whole of Dr. Gravely's paper is enough evidence, if evidence were needed, of this prime difficulty. His conclusion after a study of different styles—whether there is not fundamental unity underlying all the various styles of Indian temple architecture—is itself fully confirmatory of the soundness of this remark.

Dr. Gravely deserves to be warmly congratulated on the production of a monograph which has served to draw pointed attention to a subject which still awaits the study of competent scholars in this country, a study which is as necessary as it is difficult.

The monograph, we may add, is well illustrated and is bound to create interest in the subject to which it is devoted. It suggests the need for an architectural survey of India on lines more intelligible and scientific than we have had so far and if it did nothing more, it would have served its purpose.

C. Hayavadana Rao.

Fish and Mosquito Control.

IN a recent article Dr. B. Prashad and the writer gave a general review of the probable larvivorous fishes of India. In this article the Indian literature on the subject was reviewed and the classification of the probable larvivorous fishes of India was dealt with in a general way. Attention was also directed to the importance of biological control and suggestions were made for future work. One of our suggestions was that "Observations should also be made regarding the natural food of the various types of fishes by an examination of their stomach contents." Fortunately workers interested in the control of mosquitoes had already realised the importance of the above subject and, instead of studying the feeding habits of fishes in aquaria under laboratory conditions, had gone into the field to elucidate the natural food of the species to be utilised in anti-malaria measures. Two such recent attempts have come to the notice of the writer. Dr. Sen has studied the "Food Factors of the So-called Mosquito-Destroying Fishes of Bengal—*Panchax panchax*, *Barbus stigma*, *Esomus danricus* and *Trichogaster fasciatus*", and the data, which he presents, show that under natural conditions these fishes do not feed on mosquito larvæ; in the case of *Panchax panchax*, however, he noticed that "*Anopheles* larvæ were detected in the gut of only about ten per cent. of the total fish examined." Professors N. P. Sokolov and M. A. Chvaliova, on the other hand, in their observations on the "Nutrition of *Gambusia affinis* on the rice fields of Turkestan" remark that

"1. *Anopheles* play an important role in the food of adult *Gambusia* on the rice fields, amounting to 32·8%; Ephemeridæ, 21·9%; Rynchota, 21·5.

"2. *Anopheles* larvæ form the bulk of the food of the young fish, amounting to 64·8%.

"3. *Gambusia affinis* exterminates the *Anopheles* larvæ to about 80-90%. This shows the important role *Gambusia* plays in the ecological method for combating *Anopheles* larvæ on the rice fields."

The results of Dr. Sen and Professors Sokolov and Chvaliova are so widely different that a layman may well feel bewildered in deciding whether fishes could play any part whatsoever in the eradication of mosquitoes. A careful study of Dr. Sen's work, however, leads one to the conclusion that his technique, as detailed below, must have been mainly responsible for the results which differ so materially from those of the Russian workers. The technique employed by him was to remove the "mid-gut"* on a slide and its contents "were then squeezed out from one end on the slide and examined under the microscope". Though the next section is entitled "Analysis of Stomach Contents", in the text reference is only made to "gut" and it is difficult to make out as to which part of the alimentary canal the author refers; it is certainly doubtful whether he uses it as a synonym of stomach in fishes. In the case of fishes the contents of the stomach, which is situated between a short œsophagus and a long or short intestine, have to be studied to determine their natural food. Dr. Sen did not preserve his fishes as they were caught, but usually allowed 2 to 3 hours or longer to lapse before placing them in the preservative. It is no wonder, therefore, that Dr. Sen found the food materials in the "gut" of the fish "in an advance state of digestion".

Professors Sokolov and Chvaliova, on the other hand, record that "The analysis of *Gambusia* food was done by the usual method in ichthyology of examining the stomach contents." They found, however, that even this method proved insufficient to show the entire process of nutrition in fishes, and accordingly carried out some ingenious physiological experiments to elucidate the problem of *Gambusia* nutrition. They found that at a temperature of 30° C. "the process of digestion begins about 2 hours after the larvæ are swallowed. A complete discharge of the stomach takes place in 3-4 hours, except for the chitinous parts which remain in it longer." Low temperatures, however, cause a slowing-down of digestion. They further found that the intensity of digestion remained the same whether the fish were fed on *Daphnia* or on *Anopheles* larvæ. Further they investigated the rate at which *Gambusia* swallows larvæ and found a close correlation between it and the rate of digestion. Though they failed to achieve complete extermination of

* Dr. P. Sen informs me that by "mid-gut" he means stomach.

Anopheles larvæ even at a density of 2·3 Gambusæ per sq. mile, they found on the rice fields that the average extermination extended to 93·1 per cent. From their experiments and observations Sokolov and Chvaliova conclude that "*Gambusia* may be regarded as a sufficient agent of repression with the *Anopheles* larvæ, without applying any other methods."

The writer has for long been of the opinion that biological control of mosquito larvæ by the use of fish will prove very effective in India, but considerable work on *proper lines* remains to be done to determine the utility of the different species under field conditions; and in this connection the methods adopted by Professors Sokolov and Chvaliova should prove very helpful.

S. L. HORA.

Prashad, B., and Hora, S. L., "A General Review of the Probable Larvivorous Fishes of India," *Rec. Malaria Surv. Ind.*, 1936, **6**, 631–648.

Sen, P., "On the Food Factors of the So-called Mosquito Destroying Fishes of Bengal—*Panchax panchax*, *Barbus stigma*, *Esomus danricus* and *Trichegaster fasciatus*," *Curr. Sci.*, 1937, **5**, 357–361.

Sokolov, N. P., and Chvaliova, M. A., "Nutrition of *Gambusia affinis* on the Rice Fields of Turkestan," *Journ. Animal. Ecol.*, 1936, **5**, 390–395.

ASTRONOMICAL NOTES.

1. Comets.—The first Comet of the year was observed by Mr. Simizu in Japan. The object has been identified as Daniel's Comet 1909 IV which has not been seen since discovery in 1909. The computed period is about 6·8 years.

Comet 1937*b* was discovered on February 7, by Dr. Whipple of the Harvard Observatory. The estimated magnitude at the time was 12 and it had a short tail several minutes of arc in length. From the ephemeris based on the orbit calculated by Dr. Whipple, it is noted that the Comet will be in favourable position for observation during the next two months.

2. Transit of Mercury.—On May 11 the planet Mercury will be in inferior conjunction with the Sun and will partially transit over the Sun's disc. The phenomenon will be generally visible in Southern Asia and the central and southern parts of Africa. At Madras the ingress will occur at $2^h\ 14^m$ P.M. and egress at $2^h\ 46^m$ P.M. Indian Standard Time, and at Bombay the times are $2^h\ 18^m$ and $2^h\ 42^m$ P.M. respectively. The maximum ingress will be 7″·3, the true diameter of the planet being 12″·02.

3. Planets in May 1937.—The planet Venus will be a morning star throughout the month and will attain greatest brilliancy on May 24. Mars is a bright object rising in the early part of the night; it will be in opposition to the Sun on May 20 and will approach nearest the earth on May 28. The planet will be found a little to the west of the bright star Antares (α Scorpii). The two objects, being nearly of the same colour, present a noteworthy appearance in the evening sky. Jupiter rises about midnight and will be almost overhead early in the morning before sunrise. Saturn will also be a morning star, rising about two and a half hours after midnight in the middle of the month. The rings are gradually widening and can be seen with telescopes of moderate size.

4. The System of Capella.—The star α Aurigæ (Capella) was found by Campbell to be a spectroscopic binary with a period of 104·022 days. Later measures at Mount Wilson with an interferometer have confirmed the period. The star has a faint companion (magnitude 10·6) about 12′ distant, having the same proper motion. In *Astronomical Journal*, 1048, C. L. Stearus remarks that on photographs obtained by him, the image of this companion shows a distinct elongation and suspects, that it is also a double star. Kuiper, observing with the 40″ Yerkes' refractor, has confirmed (*Ap. J.*, Oct. 1936) the star being a close double, so that Capella appears to be a quadruple system of the ε Lyræ type.

5. New Stars.—The four Novæ which were observable about the end of 1936 are still fairly bright and can be seen even with small telescopes. Nova Herculis—the star that had its outburst in Dec. 1934—appears to be steady at the eighth magnitude with only some small fluctuations in brightness. The two Novæ in Aquilæ are slowly declining, the magnitudes of both on March 11 were estimated to be 9·7.

CENTENARIES

S. R. Ranganathan, M.A., L.T., F.L.A.
University Librarian, Madras

Parmentier, Antoine Augustin (1737-1813)

PARMENTIER, a pharmaceutist and writer on agriculture, was born at Montdidier on April 17, 1737. His early education had to be received solely at home and was rather incomplete. Later, he studied pharmacy in the shop of a local apothecary. Having held a commission in a military hospital in 1757, he again prosecuted his study of chemistry at Frankfort-on-the-Maine and later, in 1763, in Paris. In 1766, he obtained by competition, the situation of Assistant Apothecary in the Hotel des Invalides; and in 1772 he became the Apothecary-in-chief.

His Writings

He wrote about twenty-five books. His first book *Examen chimique de la pomme de terre* was published in Paris in 1773. The last book which came out in 1812 was on *Formulaire pharmaceutique a l'usage des hopitaux militaires.* The most considerable of his books was the *Economie rurale et domestique* (1790) which was in eight volumes. He began to write to periodicals rather late in life. His first paper appeared only in 1791. It came out in V. II of the *Annal. de chemie* under the title *Sur la nature et la maniere d'agir des engrais.* But once the ice was broken, he began to contribute regularly to learned periodicals. Forty-seven papers of his came out in the twenty-two years of his life that remained. He wrote his last paper just before his death and it appeared in V. 44 of the *Gilbert annal.*

His Contributions

His first contribution of note was his essay on alimentary substances which might be used in times of famine. This essay won for him the prize offered by the Academy of Basancon. He also called attention to the starchy matter in plants and especially to the cultivation of the potato. He devoted much thought to the improvement of the diet of soldiers and to the use and preparation of grape sugar. He examined the food value of several materials and wrote a treatise *On the best method of making bread.*

He died at Paris on December 17, 1813.

Bennett, Edward Hallaran (1837-1907)

E. H. BENNETT, Irish surgeon, was born at Cork on April 9, 1837. His father was recorder of Cork. His maternal grandfather was an M.D. and made some reputation as a writer on insanity. His paternal grandfather was a physician at Cork. Bennet had his education at Hamblin's School at Cork, at the Academical Institute, Dublin, and at the Trinity College, Dublin. In 1859 he graduated M.B. and M.Ch. In 1863 he became a Fellow of the Royal College of Surgeons in Ireland. In 1864 he became an M.D. and got the position of University Anatomist and of the Surgeon to Sir Patrick Dun's Hospital, Dublin. These posts he held till 1906.

His Special Field

Bennet was an authority on fractures of bones. His name has been immortalised in the term *Bennett's fracture*, which is applied to a form of fracture of the base of the metacarpal bone of the thumb. As it closely simulates dislocation, it was not recognised till 1881, when Bennett gave an account of it before the Dublin Pathological Society. As an operating surgeon, he was one of the first surgeons of Ireland to apply Listerian methods. He wrote about eight papers, the first entitled *Fractures of the costal cartileges* having come out in 1876 in V. 61 of the *Dublin journal of medical science.*

His Honours

He was a popular and effective teacher. He had the reputation of enlightening the driest subject with touches of humour. In 1880, he was elected President of the Pathological Society of Dublin. From 1884 to 1885, he was President of the Royal College of Surgeons of Ireland. From 1894 to 1897 he was President of the Royal Academy of Medicine of Ireland. From 1897 to 1906 he represented the University of Dublin on the General Medical Council. He was elected an Honorary Fellow of the Royal College of Surgeons of England. A Bronze Medal has been founded to be awarded biennially to the winner of the surgical travelling prize. It bears on one side a portrait of Bennett and on the other a metacarpal bone showing *Bennett's fracture.*

Bennett died at Dublin on June 21, 1907.

McLachlan, Robert (1837-1904)

ROBERT McLACHLAN, British Entomologist, was born in London on April 10, 1837. He was the son of a ship's-chandler, who left him some considerable property. As a boy he took great interest in Botany. When eighteen years old, he made a voyage to Australia and China, where he collected much botanical material, which was subsequently examined by the Keeper of the Botanical Department of the British Museum. About this time, however, a change came over his field of interest. This change was brought about largely by the prolific writings of Hermann August Hagen, the German entomologist, who settled in the United States and became the father of the American school of entomologists. Hagen's articles in the *Entomologist's annuals* drove Robert's interests to Neuroptera.

His Contributions

Robert McLachlan was a prolific writer. As many as 228 papers of his were published in various periodicals. His first paper appeared in 1861, in the first volume of the *Transactions* of the Entomological Society. It was entitled *Descriptions of the British species of the genus stenophylax.* His *Catalogue of the British neuroptera* was published by the Entomological Society in 1870. His chief independent work is said to be *A monographic revision and synopsis of the trichoptera (caddis-flies) of the European fauna.* This great work was illustrated by his own detailed drawings and came out during the decade 1874-84. He also wrote the article on *Insects* for the ninth edition of the *Encyclopædia Britannica.* He was mostly interested in the anatomy of insects.

His Collections

McLachlan was an enthusiastic collector. He was in constant touch with the leading neuropticists of the world, and he was able to bring together one of the finest collections of neuroptera in the world.

His Honours

McLachlan was a member of many British and foreign learned bodies. He was elected a Fellow of the Linnean Society in 1862 and of the Royal Society of London in 1877. He was the President of the Entomological Society in 1885–1886. He was entrusted with the editing of the *Entomological monthly magazine,* which he founded with others in 1864.

McLachlan died at Lewisham on May 23, 1904.

Scudder, Samuel Hubbard (1837–1911)

S. H. SCUDDER, the greatest American orthopterist of his time, was born in Boston on April 13, 1837. His interest in entomology was aroused during his first year of college by a case of butterflies in the room of a friend. He had a chequered career, having been as Assistant in the Laurence Scientific School from 1862 to 1864, Keeper of the Boston Society of Natural History from 1864 to 1870, without employment from 1870 to 1879, Assistant Librarian of the Harvard University from 1879 to 1882 and finally a Palæontologist in the United States Geological Survey from 1882 to 1892. With his library career is associated his *Catalogue of scientific serials of all countries... 1633—1876,* one of the earliest specimens of this form of bibliography.

His Contributions

Scudder was a prolific writer. His contributions numbered 791. His *Nomenclator zoologicus* (1882–84) though not quite within his special field of study is remarkably thorough and is said to be still of considerable value. His special field was orthoptera. In the course of his life, he named and described 1,884 species, of which 1,144 species and 233 genera are fossil insects. Some of his books like *Frail children of the air* (1895) and *Everyday butterflies* (1899) were in a popular key, dealing with migration, protective coloration and dimorphism ; at the same time they were so full of suggestions as to open broad fields of research. His monumental work which embodies the result of thirty years of systematic research is *The butterflies of the Eastern United States and Canada with special reference to New England.* 3 V. (1888–9). His closing years were devoted largely to fossil insects.

His Honours

He received the Walker prize of the Boston Society of Natural History in 1898. He became a member of the National Academy of Sciences in 1877 and of the American Philosophical Society in 1878. He was elected an Honorary Fellow of the Royal Society of Canada and of the Entomological Society of London. He was also a Foreign Associate of many learned bodies in several foreign countries. He has been called "the greatest scholar and the most charming writer among American entomologists".

He died on May 17, 1911, of paralysis which kept him in a disabled condition for nearly fifteen years.

INDUSTRIAL OUTLOOK.

Problems of the Paper Industry in India.

By M. P. Bhargava.
(*Forest Research Institute, Dehra Dun.*)

THE total annual consumption of all kinds of papers and boards in India in 1935-36 was 216,356 tons, as compared with 115,636 tons in 1925-26. In one decade, therefore, the annual consumption rose by about 188 per cent. The attached tabular statement summarises, under the main headings adopted in the trade returns, the quantities of the various kinds of papers and boards made in this country and those imported from abroad in the two years, 1925-26 and 1935-36.

An examination of the table brings out the following interesting facts:—

(1) That the production of Indian mills in the past has been confined mainly to writing and printing papers. In 1935-36, these mills supplied almost 65 per cent. of the country's requirements of these papers.

(2) That the annual consumption of newsprints (papers for printing newspapers) increased from 13,672 tons in 1925-26 to 34,328 tons in 1935-36, *i.e.*, by nearly 251 per cent. This type of paper is not produced in India at all at present.

(3) That the total yearly consumption of packing and wrapping papers, including kraft papers, increased from 37,073 tons in 1925-26 to 77,857 tons in 1935-36, *i.e.*, by about 210 per cent. The whole of the above tonnage is imported from abroad and about 3/4 of it consists of printed unused newspapers.

(4) That the annual consumption of strawboards, cardboards, etc., increased from 13,191 tons in 1925-26 to 28,175 tons in 1935-36, *i.e.*, by about 221 per cent. The share of the Indian production of these in 1935-36 was about 4,000 tons, or only about 14 per cent. of the total.

(5) That while the Indian production in 1935-36 was 176 per cent. of that in 1925-26, it was only 23 per cent. of the total consumption in 1935-36, as compared with 24·4 per cent. in 1925-26.

In view of the enormous forest wealth of the country, which can be utilised for paper making and of the "protection" extended to the industry by Government since 1925, the dependence of the country to such a large extent on foreign imports would appear to be rather anomalous. In the following paragraphs, the problems which face the industry to-day and which require to be solved in order to enable it to develop to its full stature, are briefly examined. For the sake of clarity and convenience almost the entire field of the consumption of papers and boards is scanned under the following main groups:—

1. Writing and printing papers (better and medium qualities).
2. Cheap printing papers including newsprints.
3. Packing and wrapping papers including kraft papers.
4. Straw-boards, card-boards, pasteboards, etc.

1. Writing and Printing Papers.

It will be seen from the table that the production of these papers by the Indian mills increased in one decade from 25,203 tons in 1925-26 to 43,530 tons in 1935-36. The increased output was rendered possible entirely as a result of the successful investigations by the Forest Research Institute and the Indian paper mills on the production of chemical pulp from bamboos. Prior to 1925, the industry depended mainly on *sabai* or *bhabar* grass (*Ischæmum angustifolium*) as its staple raw material. The available quantities of this grass were not adequate to permit expansion of the industry on an economic basis. In bamboo the industry has found a material, sustained supplies of which are available in abundance in different parts of the country and from which a large variety of writing and printing papers can be produced at an economic cost. The use of bamboo has enabled the industry, with the aid of "protection" granted by Government, to expand and capture almost the entire increase, in the

last decade, in the demand of writing and printing papers, which would otherwise have been met by foreign imports. It is true that over 12,000 tons of writing and printing papers, consisting of superior quality and special papers, *e.g.*, banks, bonds, art, litho, etc., are still imported into the country. These papers could be made from bamboo and other available raw materials, but as the quantity of each individual variety is too small, its manufacture cannot be taken up profitably by an Indian mill, particularly as the distribution of such manufactures over the vast area of India would be uneconomic. Until, therefore, the demand for the individual papers increases considerably, their manufacture in this country is likely to remain uneconomic. Excepting these papers, therefore, India is now in a position to meet not only her present requirements of writing and printing papers but also to supply the greatly increased demands of the future. To enable her, however, to retain possession of this market, it is essential, that research on bamboo, which has already put the industry on its legs, should continue, so that, in due course, the bamboo paper industry can successfully compete, without the aid of "protection", with the long-established and highly advanced wood pulp industry of the West, in which extensive research is still in progress in full vigour. Investigations to this end and with a view to improve continually the technique and lower the cost of production, form an important part of the programme of work of the Paper Pulp Section at the Forest Research Institute at Dehra Dun.

2. Cheap Printing Papers including Newsprints.

The consumption of these papers increased from about 24,000 tons in 1925-26 to about 46,000 tons in 1935-36, *i.e.*, by about 190 per cent. With the advent of the Reforms and the spread of education among the masses the consumption of these papers is bound to increase at a much higher rate in the coming years. It has not yet been possible to manufacture these papers at competitive prices in this country, as in their production a large proportion (70 per cent.—80 per cent.) of cheap mechanical pulp (*i.e.*, pulp made by mechanical processes of grinding without the use of any chemicals) are required, and the production of this kind of pulp from indigenous materials has not hitherto been attempted. The use of foreign mechanical pulp for the manufacture of these papers has not been feasible on account of the heavy protective import duty. Cheap mechanical pulp must, therefore, be made available to the paper-maker in this country in order to enable him to capture the large and growing market for these papers. The Forest Research Institute has already taken this problem in hand. The erection of suitable machinery for carrying out the experimental work is nearing completion and a systematic investigation on the possibility of using bamboos and woods for the production of mechanical pulp is in train.

3. Packing and Wrapping Papers including Kraft Papers.

The use of kraft paper (strong brown paper used for packing purposes, often glazed on one side and rough on the other) on a large scale has only developed in India within the last few years. In 1935-36 the imports of these papers were 9,544 tons. As the use of this paper is likely to grow considerably in the near future, its manufacture in the country offers bright prospects. Recently experiments have been carried out at the Forest Research Institute on the production of kraft paper fron bamboos, the only raw material which is at present available in sufficiency for the purpose. The results obtained are very promising and it is hoped that the investigations, when completed, may establish the possibility of producing satisfactory qualities of kraft papers from bamboos and that their manufacture will soon be taken up in the country.

A remarkable feature regarding the other cheaper varieties of wrapping and packing papers is the enormous consumption of imported old newspapers. In 1935-36, while the import of ordinary wrapping papers was 10,730 tons, that of old newspapers was 57,583 tons or more than double what it was in 1925-26. These old newspapers are, as is well known, largely used for wrapping foodstuffs, fruits, provisions, etc., in bazaars. Such a use is admittedly very unhygienic and detrimental to public health. The price at which the old newspapers are dumped into the country is so low that it is impossible to manufacture any

paper, even from the cheapest material available, to compete with them. In the interests of public health and of the development of a large and new industry it is obviously necessary that the present undesirable use of old newspapers should be discontinued. The only effective measures which can be taken to bring this about are :—Firstly, the production of very cheap wrapping papers in the country. For this purpose it is indispensable that cheap pulp, both chemical and mechanical, should be available to the paper maker. As has been mentioned above, investigations are in progress at the Forest Research Institute to cheapen the cost of production of chemical pulp, and experiments have already been initiated to explore the possibilities of mechanical pulp from indigenous materials. It is hoped that success will attend these investigations and that the manufacture of cheap wrapping papers will become economically possible in the near future. Secondly, it will be necessary to educate public opinion against the use of old newspapers for wrapping up foodstuffs, and lastly it may be found advisable to put a heavy protective duty on the imports of old newspapers, once the possibility of producing cheap wrapping papers in India is fully established.

4. Straw-boards, Card-boards, Insulation-boards, etc.

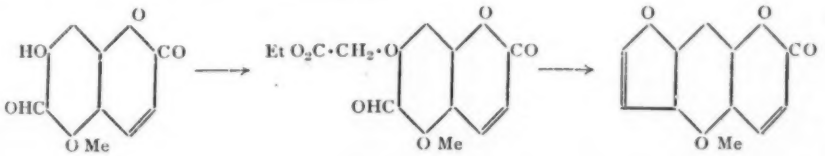
The consumption of boards has more than doubled in the decade ending 1935-36. The Indian production of these products is barely 14 per cent. of the total demand. The smallness of the aggregate demand, and the non-availability of cheap materials such as mechanical pulp or agricultural wastes have principally been responsible for the very slow growth in the manufacture of these products in the country. The phenomenal growth of the sugar industry in the last few years has, however, raised the problem of profitably disposing of surplus bagasse (crushed sugarcane). The Imperial Council of Agricultural Research has recently made a grant to the Forest Research Institute for investigating the possibility of utilising bagasse for the production of wrapping papers, insulation-boards, straw-boards, etc. These investigations are on the point of being started. The availability of mechanical pulp and the utilization of agricultural wastes will, it is hoped, render practicable the establishment of a board manufacturing industry in India, particularly as with the industrial and commercial development of the country, the demand for boards of various kinds is likely to become large enough to enable their manufacture to be taken up on a profitable basis.

To sum up, during the last ten years the consumption of papers and boards in India has increased on the average by about 10,000 tons per annum. With the industrial and economic development of the country and the widespread diffusion of literacy among the masses, the demand for papers, particularly of the cheaper variety, is bound to increase more rapidly in the future. The present *per capita* consumption of paper in this country is hardly 1½ lbs. as compared with 150 lbs. in the United States of America, and is the lowest of all countries in the world, except perhaps China. There is thus an enormous scope for the growth and development of the paper industry in India. A well-organised plan, enterprise and sustained and intensive research are needed to exploit the natural resources and render the country self-sufficient with regard to her requirements of a commodity of vital importance for national development and for the progress of civilisation. Investigations on subjects of immediate industrial importance are, as has been shown above, in progress at the Forest Research Institute. If some other technical institutions and universities in this country, where facilities for applied chemical research exist, also interest themselves in problems connected with these subjects and work in liaison and co-operation with the Forest Research Institute, it would help towards the sound and more rapid progress of one of the major industries of the country. The industry at present employs more than 6,000 hands and the total value of its imports amount to about 3 crores of rupees. If the major portion of these inports is manufactured in India, employment would become available to a considerably greater number of people, and the natural resources of the country would be utilised to the fullest advantage.

Item No.	Description of Papers and Boards	Imports Tons		Made in India Tons		Total consumption Tons	
		1925–26	1935–36	1925–26	1935–36	1925–26	1935–36
1	Writings and Printings including *badami*, envelopes, etc.—						
	(*a*) Protected	8,637	12,095				
	(*b*) Not protected (mostly printing papers)	10,490	11,654				
		19,127	23,749	25,203	43,530	44,330	67,279
2	Newsprints	13,672	34,328	..	..	13,672	34,328
3	Kraft	..	9,544	..	..	..	9,544
4	Packings and wrappings ..	8,805	10,730	Included in item No. 6		8,805	10,730
5	Old newspapers	28,268	57,583	..	..	28,268	57,583
6	Other kinds	2,382	3,846	3,018	2,181	5,400	6,027
7	Paper manufactures	1,442	2,019	..	..	1,442	2,019
8	Straw-boards	10,933	15,090	..	4,000 (approximate figure)	10,933	19,090
9	Card-boards, Mill-boards, Pasteboards, etc.	2,258	9,085	..	..	2,258	9,085
10	Manufacture of boards	528	671	..	..	528	671
	Total	87,415	166,645	28,221	49,711	115,636	216,356

RESEARCH ITEMS.

A Partial Synthesis of Bergapten.—Howell and Robertson (*J. C. S.*, 1937, 293) have recently confirmed the accepted structure of bergapten (III) by synthesising it from *apo*xanthoxyletin (I), the orientation of which has been established by Robertson and Subramaniam. (*loc. cit.*, *p.* 286). (I) on condensation with ethyl bromoacetate in acetone containing potassium carbonate gave the ester (II). The corresponding acid yielded, on cyclisation and simultaneous decarboxylation with acetic anhydride containing sodium acetate, a product (III) identical in every respect with natural bergapten. The parent coumarin of (I) has also been synthesised but its conversion into (I) has not yet been achieved.



(I) (II) (III)

T. S. W.

Haematoporphyrine as a Cure for Melancholia and Endogenic Depression.—The efficacy of Hæmatoporphyrine in the treatment of certain mental disorders is recorded by Dr. Jakob Huehnerfeld who has experimented on the method for the last seven years (*Forschungen und Fortschritte*, 1936, **12**, 343).

These experiments were commenced in 1929 on animals and later confirmed by Dr. Huehnerfeld and co-workers by clinical experience of patients suffering from melancholia and endogenic depression. It was established that Hæmatoporphyrine acts firstly photo-dynamically, secondly as a stimulant and lastly as a regulator of normal animal metabolism. This threefold action is responsible for the increased appetite, better physical appearance, sparkling eyes and the increased general activity of the patient. Objectively, the calcium, potassium and sugar contents of the blood as also its pH value become more normal. An increase in the Hæmoglobin content of the blood is also noticeable. Extensive clinical experience with over 400 patients have convinced Dr. Huehnerfeld that Hæmatoporphyrine is the specific casual agent responsible for this improvement.

The optimal dosage is 500–700 mg. of Hæmatoporphyrine spread over a period of 40–60 days. No secondary complications were noticed. Hæmatoporphyrine is already marketed in Germany under the trade-name "Photodyn".

EMMENNAR.

Alba—a New Palladium-Silver-Gold Alloy.—Dr. Alfred Jedele of Hanau describes in *Forschungen und Fortschritte* (1937, **13**, 95), Alba, a new palladium alloy which can well replace the usual gold compositions extensively used in dentistry and in the manufacture of fountain pen nibs. The alloy has the approximate composition of 30 per cent. palladium, 60 per cent. silver, 5 per cent. gold and smaller proportions of other (undisclosed) constituents. The molten alloy is quite mobile and easy to work with. And apart from the fact that the sp. gr. of the alloy is about 25 per cent. less than that of 20-carat gold, the $E_{\frac{1}{2}}$ potential of the alloy against lactic acid is about the same as that of the gold alloys hitherto employed in dentistry, so that the use of dentures made of the new alloy along with existing "gold" plates does not lead to any corrosion or discoloration.

The economic value of the new alloy to Germany handicapped for want of adequate foreign exchange resources can be gleaned from the fact that that country consumes annually for dentures alone 4000 Kg. of gold, all of which has to be imported. The use of the substitute alloy Alba in place of the gold alloys would save the country, it is estimated, nearly 74 per cent. in import costs.

EMMENNAR.

Biochemistry of *Sonti* Fermentation.—In Eastern countries, a large variety of alcoholic beverages and liquors are prepared by symbiotic fermentation of rice, the symbionts being usually a fungus and a yeast. The *Sonti* fermentation (K. Rami Reddi and V. Subrahmanyan, *Trans. (National Inst. Sci.*, 1937, **1**, 293–331) which is practised in some of the Andhra Districts of the Madras Presidency belongs to this class but presents certain unique features which distinguish it from other fermentations of its type. The chief object of the fermentation is to produce a highly digestible form of rice, particularly suitable for infants and invalids. An analysis of the product (*Sonti annam*) shows that it contains very little starch but is chiefly made up of sugars and dextrins together with small quantities of organic acids, esters and alcohol. The organism chiefly responsible for the digestion of rice is a hitherto undescribed species of *Rhizopus* (tentatively named *R. sontii*) characterised by its powerful amylase which is particularly effective on rice starch. The other organisms associated with the fermentation—*Dematium* sp. (?), *Saccharomyces cerevisea*, *Torula* sp. (?) (*Torula Hansen ?*) and *Micrococcus perflavus*—have also been described. The influence of various factors on the course of fermentation have been studied and particular attention drawn to the fact that under certain conditions, very high yields of alcohol can be obtained. The significance of the fermentation in relation to public health and its possible industrial applications have been indicated.

Genetical and Cytological Studies of Hybrids.—Interesting findings are reported by F. A. E. Crew and P. C. Koller (*Proc. Roy. Soc. Edin.*, 1936, **56**, Pt. 3, 210) who have examined the behaviour of the intergeneric hybrid of *Cairina moschata* and *Anas platyrhyncha platyrhyncha*. It has long been known that these genera are fertile *inter se* but their hybrid is infecund. The progeny of *Anas* female and *Cairina* male consists of abnormal and infecund males and females, while the progeny of *Anas* male and *Cairina* female consists of infecund males and females with normal sex behaviour. A number of cytological abnormalities were noticed in the hybrid, like chromatid bridges and fragments, precocious activity of some dot-chromosomes, formation of giant cells with multiple nuclei, degeneration of cell due to vacuolation, etc. But the sterility of the hybrid is mainly due to the abnormal development and behaviour of the spindle, for, the parental chromosomes in the hybrid show every sign of regular pairing during meiosis, the metaphase plates of which become disarranged due to spindle abnormality.

A New Pelagic Larval Ceriantharian.—N. K. Panikkar (*Zool. Anz.*, 1936, **115**, 9/10, 250), has reported the occurrence of a larva belonging to a species of Ceriantharian which he has called *Apiactis bengalensis* in the waters off the coast of Madras. A tiny animal, not exceeding 3 mm. in length, the larva has certain distinctive features which separate it from the allied *A. denticulata* and *Isapiactis obconica*. From the former species it differs in the size and arrangements of the marginal tentacles as well as in the thicker mesoglœa and the absence of craspedonemes while from the latter it differs in regard to the acontia and the directive tentacles. The position of the new species with reference to the two above forms is discussed at the end of the paper.

Need for a Soil Survey of India.

A DISCUSSION on the need for A Soil Survey of India was held during the Indian Science Congress Week at Hyderabad (Jan. 1937), Rao Bahadur B. Viswa Nath presiding.

In introducing the subject the President stated that the answer to such a general proposition as "the need for a Soil Survey", would undoubtedly be in the affirmative: but the point for consideration was about the type of Survey. In arriving at an answer to this question, it would be necessary (1) to consider the objects of a soil survey, (2) to ascertain what had already been done in India and what was being done and (3) to define what was wanted. A soil survey could be carried out for one or more of many purposes. For example, it could be carried out for settling new land. It could be carried out for ascertaining the physical and chemical characteristics of the soil with reference to manurial treatment, and irrigation projects. In regard to the first point there were about 150 million acres of cultivable waste land. All this land was, however, not situated in one compact block but was scattered in small patches all over India. It was necessary, therefore, in the first instance to ascertain the nature and the disposition of the waste land and this would perhaps form a subject of enquiry by the Departments in the Provinces. During the past quarter of a century soil surveys were in progress in the different parts of the country to ascertain the manurial and fertiliser requirements of the soils. As a result, a considerable amount of valuable data were obtained and these were being used in advising on manurial programmes and fertility projects. In recent years, enquiries had been commenced in connection with irrigation and drainage problems with a view to ascertain the most suitable alignment for irrigation and drainage channels. There remained, therefore, the survey for the classification of soils so that the information obtained would be useful in interpreting the response to manurial treatments and for research and advisory work. They had, therefore, to consider carefully what methods of survey were needed for this purpose.

In England the basis of classification in the early days was geological, the assumption being that each geologisal variation gave rise to its own type of soil. Subsequently this was not found to answer the purpose, as the effect of climate, altitude, topography and other factors was considerable, so that soils formed from the same geological parent material varied considerably. Then there was the Russian and American methods of classification which were chiefly based on the study of the soil profile.

The soils of India could be very broadly classified into the Indo-Gangetic alluvium covering about 300,000 sq. miles: the tract of black soils covering a total area of about 200,000 sq. miles, and a red soil tract including laterite soils of 150,000 sq. miles. The black soils, although derived from different basic materials, possessed common agricultural characteristics and a silica alumina ratio between 3 and 4. The large tract of Indo-Gangetic alluvium was almost alluvial in nature. The soil profile in this case did not appear to be so important as it was elsewhere, but surely it should be possible to differentiate profiles even in this huge block of alluvium with reference to the relative intensities of rainfall, evaporation and temperature. The ratio of rainfall to temperature for the different parts of India varied from 0·10 to 1·5. A broad classification of areas might be made into

North-east India,
North-west India,
North Central Alluvial India, and
Peninsular India,

which again could be subdivided on the ratio basis and classified with respect to texture and composition.

He would be glad if speakers would kindly bear in mind these points and confine their remarks to the methods of survey that might be considered necessary on an All-India basis.

Messrs. Wadia and Roy spoke emphasising the geological aspect of soil survey. Dr. Puri discussed the means of approach to the problem and the methods to be employed and suggested that a committee of people engaged in soil survey should draw up an agreed programme of work and co-ordinate results. Mr. Wad said that valuable data are available from Settlement Surveys and that they should be examined and utilised. He gave data collected by him in Central India. Rao Saheb Bal spoke with reference to the soils of the Central Provinces and Dr. Kasinath on the soils of the Madras Presidency.

In the course of his address SIR JOHN RUSSELL said that he would confine himself to indicating various directio is in which local surveys can profitably be made.

In regard to the cultivable wastes of 150 million acres mentioned by Mr. Viswa Nath, one cannot help feeling that there is a good deal of it that could even in present conditions be brought into cultivation, and one advantage of a survey will undoubtedly be that it will enable us to ascertain which are the most promising areas for reclamation.

In regard to manurial experiments a good deal of information had already been obtained and this will be extended now that modern methods are so widely being used. A soil survey in relation to the area served by the experimental station affords an effective method of showing how far the experimental results are likely to be applicable in practice.

Further, there is the problem of Irrigation. I attach great importance to making a proper survey of any region that it is proposed to irrigate. Trouble from water-logging is likely to follow irrigation unless the scheme has been planned as guided by a previous soil survey. I could give instances from different parts of the world which I have visited where the scheme considered from the engineering point of view has been admirable, but from the soil point of view it was bad.

Coming now to the important problem of classification, several methods have been used. The earliest was textural. Then came the geological

basis: then climatic, then the profile basis. All are useful, but objection can be taken to all of them. Geological data, however, are invaluable for providing information in respect to water-supply, where it is essential to know the nature and position of the various strata, their permeability and their relation to the ultimate supplies of water. Studies of this kind would be useful in famine areas.

Other problems of soil survey arise in connection with forestry. Forest conservation is an effective way of reducing or even preventing soil erosion.

Problems connected with laterite soil and black cotton soils offer exceptional scope for study in India.

One of the modern methods of soil survey is to have it on the soil profile. Unfortunately, most of the Indian soils I have seen have no very marked profile such as can be seen in other parts of the world. A good deal of soil work is being done in India and it would undoubtedly be a great advantage to put all local surveys on to a uniform basis so that the results can be collated and brought together. It is not necessary to adopt any one basis of classification. Soil investigators are by no means agreed on the matter, and numerous systems have been proposed. The important point at the present time is that the soils should be fully described and that the same methods of description should be used by all Indian workers. Dr. Puri's suggestion is sound that the Indian soil workers should constitute a committee to draw up an agreed basis for describing the soils and should indicate the methods of examination to be adopted. It would further be necessary to arrange for some central body or for some institution to collate the results and prepare the maps and so to put data on record that will be useful to all concerned with soil management and with agriculture.

Mr. Champion read a note prepared by Dr. Gorre with reference to plant cover and said that before deforesting soils for agricultural purposes, sufficient consideration should be paid to the soils, protective and water storage aspects of the natural plant cover.

Practically all sloping grounds in the drier parts of India are of some importance as a source of water to the plains dwellers either for irrigation, town water or electric power, and its efficiency in catching and storing water depends very largely on how for the natural soil profile has been maintained and developed by preserving the natural plant cover.

I submit that any form of soil survey which may be taken up should cater for this method of land use. The survey should register the relative efficiency of the existing plant cover in maintaining the optimum soil profile, and it should also indicate whatever changes are taking place in the building up or degradation of the existing profile. The view-point which regards soils *in situ* as entirely static and permanent will fail to give a record of permanent value because in many areas the soil profile is being rapidly destroyed through bad agricultural and pastoral practices. The soil survey must take cognisance of this fact and one member of each mapping party should be sufficiently erosion-conscious to be able to record obvious tendencies of this nature. The cumulative denudation which is taking place in many parts of the western provinces is leading inevitably to desiccation. By this I do not infer that the total rainfall is being appreciably reduced, but that the ground is being rendered less capable of absorbing the available rainfall.

Blood Substitutes.

THE blood of Vertebrates remains one of the most baffling of animal fluids. While its constitution is fairly definitely known, it has as yet been impossible to simulate it or provide an efficient substitute for it. And seeing that almost every day the need for an adequate substitute for blood is felt by the doctor, by the physiologist and by the biologist, it appears that our efforts to provide them with a successful blood substitute need to be intensisfied.

The literature on the subject is vast and extensive. With a view to find a working substitute for blood because of its great importance in clinical practice, biologists, chemists and medical men have been trying for a long time to systhesise a substance which may take the place of this fluid in the Vertebrate body. History goes back to the middle of the last century when the first attempts were made to replace the blood of frogs by salt solution. Since then the accumalation of literature has become very extensive; W. R. Amberson[1] has recently provided an illuminating review on the subject.

The first and foremost point of importance to be remembered in the study is that there has to this day been no complete substitute for bloods. In all the substitutes so far known some constituent of normal blood must be present. Nor is it possible to imagine,—let alone make,—a substitute for hæmoglobin. All our efforts must therefore rest in an attempt to make but the vehicle in which must be present hæmoglobin, either in a state of suspension or in the form of red cells.

A variety of conditions are to be fulfilled if a substitute for blood can be practicable, the most important of which are the ability to maintain an adequate pressure and volume and a tendency of the materials constituting the fluid not to leave the blood stream. These two are indeed the prime difficulties in the making of any fluid substitute for blood, for in many of them, either the required volume and pressure are not maintained or else, the materials of the fluid tend to leave the blood stream quickly,—very often in the course of a few hours.

Red cells are not a necessary constituent of blood but hæmoglobin in solution must be present; then, blood will be performing the dual function of maintaining the osmotic pressure and carrying oxygen,—a duality not found in any vertebrate,

[1] *Bid. Rev.*, January 1937, **12**, No. 1, 48.

though in many invertebrates where the hæmoglobin is in solution, this is possible. Experimental evidence shows that in vertebrates, this condition of dissolved hæmoglobin in blood is not workable, for hæmoglobin tends to leave the blood vessels quickly, passing into lymph to be taken up by the cells of the reticulo-epithelial system. It also becomes changed into methemoglobin so that it is not possible to maintain life after 36 hours.

Of the blood substitutes to be considered here, the most ancient but the least efficient are solutions of crystalloids which are apparently useless as substitutes as they leave the blood stream quickly and are unable to maintain blood volume and pressure. Isotonic sodium chloride solution with or without the addition of citrates and lactates has been used extensively and while differences of opinion still exist regarding the efficacy of these solutions, it is almost certain that none of these solutions can maintain life.

The next in importance are substitutes like blood plasma and blood serum which contain sufficient colloidal material to give osmotic pressure approximating to that of normal blood. Of these, blood plasma is preferred to blood serum on account of the fact that in the latter vaso-dilator and constrictor substances are found in the act of clotting.

The only effectve and practical substitute are carefully prepared gum-saline solutions with suspended, washed red cells from the same species. First used by Carl Ludwig (1863), the importance of gum-saline substitute was realised during the Great War when large quantities were used in clinical practice. Gum-saline has a number of inherent difficulties which greatly minimised its importance. The great sedimentation rate caused by it and the tendency of gut to coat the red cells thereby reducing their ability to combine with oxygen are two of the most outstanding. Added to this, there is evidence to show that gum leaves the blood stream and cannot maintain the colloidal osmotic pressure longer than 48 hours and that gum tends to get fixed in certain organs, especially the liver, thereby diminishing the concentration of the plasma proteins by blocking the liver. But these are comparatively minor difficulties and the author's own researches lead him to conclude that next to blood plasma this is the most effective substitute and in hospitals and clinical laboratories all over the world, the use of gum saline is on the increase. Gelatine saline which has sometimes been used is incapable of acting as a substitute because gelatine leaves blood quickly and it tends to hasten coagulation and intravascular clotting.

SCIENCE NOTES.

Wood is Good.—(*Bulletins of the Timber Development Section of the Forest Research Institute, Dehra Dun*) by S. Kamesam, M.I.E., with a Foreword by H. Trotter, Dehra Dun, 1936.

The *raison d etre* for this series of Bulletins is best summarised by Captain Trotter in his Foreword to the series as follows: "In the past, steel and concrete have been looked upon as the chief structural materials of the engineer. This has been due to the fact that these two materials have been widely advertised and strongly assisted by powerful organisations, whereas wood being nobody's child has gone by default."

Though the Bulletins are frankly propagandist, it is recognised that "there is a right and wrong place for everything....All we ask is that it should be given a fair hearing....".

In more advanced countries, organisations like the Timber Development Association of England undertake this kind of propaganda. In the absence of any such institution in India, the Forest Research Institute is devoting more attention to this aspect of publicity work none too early; for, on account of the persistent, intensive and subtle advertising campaigns by rival structural interests, timber has a lot of leeway to make up.

The Bulletins are singularly free from abstruse technical terms and what is perhaps more important from overstatements and exaggerations. The crisp narrative is all the more effective on account of its direct simplicity. One could however wish that the get-up of the Bulletins were more in consonance with the large stakes involved in the adequate ultilisation of Timber.

"Wood is Good" Bulletins supplement and form a very necessary counterpart to the technical publications of the Forest Research Institute.

EMMENNAR.

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The Preparation of Alumina and Sulphur-Dioxide from Bauxite Gypsum Mixtures.—[By V. S. Dube, M. B. Rane and M. Kanakaratnam. *Bulletins of Indian Industrial Research*, 1937, No.6.]

This paper describes the results of experiments in which mixtures of bauxite and gypsum in different proportions were heated to temperatures ranging from 1000° to 1280° for periods varying from 2 to 8½ hours. 2 g. of the bauxite were employed in each experiment (except in one experiment, wherein 5 g. were taken), and the proportion of bauxite to gypsum in the mixtures ranged from 3 : 1 to 1 : 3. The furnace employed for the work was of the coal-fired muffle type and is reported to have been maintained at the required temperature for a specified time with a variation of not more than 10°.

It was found that the reaction between bauxite and gypsum was appreciable at 1000° and complete at 1250°. The most suitable conditions for the preparation of alumina from bauxite and for the complete explusion of sulphur trioxide from gypsum were found to be present when mixtures of bauxite and gypsum in the ratio of 2 : 5 were heated to 1200°–1250° for a period of 6 to 7 hours.

K. R. K.

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The Jewish Communities of Cochin, India; their Racial Affinities.—At the ordinary monthly meeting of the Royal Asiatic Society of Bengal, held on Monday, 5th April, ELEEN J. W. MACFARLANE

gave a paper on *Racial Affinities of the Cochin Jewish Communities*. The Jews of Cochin totalling 1,451 in 1931, are divided into 2 endogamous communities, the White and the Black Jews. The White Jews are a minority of under 150, claiming origin from Palestine in the first century A.D. They aver that the Black Jews are the descendants of Indian convert slaves of their ancestors, and are not of the Jewish race. The Black Jews declare that they are descended from Jews who came from Palestine before the Christian era, and explain their brown skins by a long sojourn in the Tropics; according to them, the White Jews are new arrivals within the past 400 years. In order to throw light on this controversy, serological data were obtained. They show that the distribution of the blood groups in the two communities is entirely dissimilar. The White Jews show 62 per cent. Group A. This is due to inbreeding for the two largest families, who have intermarried frequently, are now apparently homozygous for gene A. The Black Jews show a disproportionate high percentage of Group O—73.6 per cent. This group was found to be very high among the low castes and outcastes of Cochin. Native slaves and concubines would come from these poor classes, and the chances are 7 to 3 that a low class woman will carry the recessive gene R of Group O. Additions to the community have evidently taken place from Group O persons. Physically the Black Jews resemble the local Moplah Mohammedans who are descended from Arab traders and local women. Consideration of the judgment of the Great Rabbi concerning the Black Jews and of the blood grouping and physical anthropology of Jewish communities in other parts of the world shows that Judaism is a culture and not a race in the biological sense. Jewish people in different regions are dissimilar in racial make-up. In Cochin, social classes have become endogamous castes. Since the Jews are patriarchal, children belong to the father's race, the Black Jews are right in contending that they are "True Jews".

The other papers read at the meeting were:—J. C. DE: *The Development of the Theory of the Divine Nature of Kings in Assam*. K. KRISHAN NAIR: *An Abnormal Specimen of* Silures Cochinchinensis *cur. and val. showing Eversion of Stomach into the Pharyngeal Cavity*. D. D. MUKHERJI: *An Abnormal Brown Trout* (Salmo fario *Linn.*) *showing Eversion of Stomach into Pharyngeal Cavity*. M. H. KYAW AND G. E. GATES: *The Earthworm Populations and the Formation of Castings in Rangoon, Burma*. KALIPADA BISWAS: *Common Diatoms of the Loktak Lake, Manipur, Assam*. K. SEN: *Some Notes on Tural Customs of Dinajpur District*.

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Nutrition Research in India.—Considerable interset is being taken by official and unofficial organisations concerned with the health and well-being of the people in the scientific study of human nutrition in India. Hitherto the view that malnutrition is prevalent has rested on *a priori* reasoning, on general knowledge of conditions prevailing in the villages and poorer quarters of towns and cities; on scattered observations regarding the existence of food deficiency diseases; on animal experiments and on pronouncements of experts, rather than on exact data collected by systematic research (says a press communique issued by the Director of Public Information under date 5-4-37). Research in India is now being organised for the collection of these fundamental data, which will enable the whole problem to be defined and clarified, and vague general statements replaced by precise knowledge. The principle centre of research on nutritional problems in India is Coonoor, where during the past 15 years pioneering work on the various aspects of the science of nutrition has been carried out. A systematic survey of nutritive value of some 200 common Indian foodstuffs as regards their content of calories, proximate principles, calcium, phosphorus and iron was recently carried out. The Vitamin A and carotene content of some 160 foods have also been investigated and a similar number of foods have been examined for their Vitamin C and about 50 for Vitamin B_2 content. Dietary Surveys are being carried out by the Coonoor and Calcutta Research units and attempts are being made to study the effect on health and physique of various types of diet. Enquiries into the "state of nutrition" of children in day schools of South India have shown a widespread prevalence of malnutrition and symptoms of food deficiency diseases are very common. Basal metabolism enquiries are being carried out and the results will be of value for establishment of standards of calorie requirements. It is proposed to select and train workers for various provinces for nutritive work and with the help of such workers attached to Public Health Departments, it will be possible to determine the height-weight-age averages in different social groups; to detect malnutrition in schools; improve the dietary; to plan institutional diets, and organise propaganda work in towns and villages.

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Researches on Lac.—A copy of the *Report of the Indian Lac Cess Committee* for the first quinquennium ending 31st March 1936 has just been published. This heralds the publication of annual reports of the committee hereafter, in accordance with the Committee's recent decision. The *Report* contains a brief account of the work done by the Indian Lac Cess Committee during these five years, in order to safeguard the interests of the Lac Industry in India. To meet the situation, biochemical work has been considerably curtailed and much more attention is bestowed upon the standardisation of the lac products and their utilisation in Industry.

Reference is made to the increase in the lac cess with the object of enhancing the finances of the Lac Cess Committee and to the reconstitution of the Committee on the lines of the Imperial Council of Agricultural Research. The detailed statements of the receipts and expenditure for the five years indicate that increasing amounts of money are furnished for research activities in India and abroad to consolidate the position of lac. Notes on the production of lac and the trade in lac are also incorporated in the report.

A succinct account is given regarding the researches on lac products in the Indian Lac Research Institute, and in the United Kingdom under the ægis of the London Shellac Research Bureau. The initiation of co-operative research

on the uses of lac in the electrical industry at the laboratories of the Metropolitan-Vickers Electrical Co., and on its use in rubber goods at the Research Association of British Rubber Manufacturers should prove of great value to the development of the Lac Industry.

The report concludes with a useful and exhaustive list of publications of the Indian Lac Research Institute and the London Shellac Research Bureau which cover all aspects of lac research—biochemical investigations, cultural practice, and industrial applications.

A. V. S.

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The Botanical Society of Bengal.—The First Annual Meeting of the Society was held on the 4th March in the Botanical Laboratory, Calcutta University, Ballygunj Circular Road, Calcutta. Prof. S. P. Agharkar, Vice-President of the Society, presided.

The Council's report for the year records an all-round progress in the work of the Society. The number of ordinary members on the rolls was 65. The Society organised 9 scientific meetings during the year at which 10 original papers were read and discussed. Popular lectures and excursions were also organised, and during the coming year, it is proposed to organise excursions to study the local flora and collect materials.

Prof. S. C. Mahalanobis was elected President of the Society for the coming year, and Dr. G. C. Sengupta and Mr. A. K. Ghosh were elected Hon. Secretaries.

A botanical exhibition and conversazione were organised on the occasion, and Prof. S. P. Agharkar delivered a popular lecture on the "Flora of Nepal".

* * *

The Indian Associaton for the Cultivation of Science.—The appendix to the *Annual Report* for the year 1936, which has just been published, gives a short account on the scientific work of the Association. The work has been classified under: Absorption and Fluorescence spectra of Organic Substances; Optical Studies on organic crystals; Magnetic studies on organic crystals; Approach to absolute zero of temperature; The magnetic anisotropy of paramagnetic hydrated crystals; Magnetic studies on graphite; Diamagnetic susceptibilities of organic substances in different physical states; Studies on magnetic double refraction; X-Ray studies on the structure of crystals; Refractivity and dielectric constant; Maxwell effect in liquids and studies on constant paramagnetism. The Association has a very high established tradition as a centre of Physical Research in the country. 54 papers were published in the *Indian Journal of Physics* during the year.

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Institution of Chemists (India).—The annual Meeting of the Institution was held on the 27th February at the University College of Science and Technology, Calcutta. In the course of his Presidential Address Mr. N. N. Sen Gupta dealt with the work of the Institution during the past nine years of its existence and suggested the initiation of fresh activities which will bring it "visibly nearer the achievement of its declared object". The institution has served as the association for Applied Chemistry in India and "is capable of rendering important service to the cause of applied chemistry". The President stressed the "possibility of active co-operation between the institution and the Indian Chemical Society, in fact among all chemical associations which may eventually arise in this country so that a representative chemical block, such as the Chemical Council of Great Britain may supervise the activities of the various societies".

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Prof. Birbal Sahni, D.Sc., Sc.D., F.G.S., F.A.S.B., F.R.S., the distinguished Indian Palæobotanist, will shortly proceed to Moscow, to attend the 17th session of the International Geological Congress, which will come off in July next. He has accepted the invitation of the Congress to take part in the symposium on Palæoclimates. At a recent meeting of the Council of the Lucknow University, Prof. Sahni was appointed a delegate of the Lucknow University. He will also represent the Indian Academy of Sciences, at the Congress.

Prof. Sahni, a distinguished student of Prof. A. C. Seward, is well known for his contributions relating to the studies of extinct plants which have led him into the domian of geology. His scientific achievements which deal largely with the floras—past and present—of India and of the Southern Hemisphere, are marked by a broad philosophical outlook and in.ensive field researches. He was one of the Vice-Presidents of the International Botanical Congress, Cambridge (1930), and again of the Sixth Congress, Amsterdam (1935).

* * *

The degree of **Doctor of Science of the London University** has recently been conferred on Dr. S. Ramachandra Rao, M.A., Ph.D., Professor of Physics, Annamalai University. Prof. Rao has made a number of contributions to the study of magnetic properties of colloidal particles of metallic elements. We offer him our warmest congratulations.

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Improvements in Cotton.—The *Annual Report* of the Indian Central Cotton Committee for the year ending 31st August 1936, which has just been published, gives a reasoned account of improvements in cotton production, the extension of improved types into general cultivations, and in the marketing conditions and manufacture of Indian cottons. Valuable information has been collected as a result of investigations into the possibilities of growing cotton of long and medium staple in the present short staple cotton areas of India. As a result of the exhaustive work carried out under the auspices of the Committee it has now been possible to control the Pink Boll-worm pest which was responsible for the destruction of 25–50 per cent. of the crop in the United Provinces. The United Provinces Cotton Pest Control Act requires all cotton seed, meant for sowing, to be subjected to heat treatment. During the year, the Committee financed 29 research schemes, and 17 seed extension and marketing schemes, the total amount sanctioned being Rs. 5,75,000. Several interesting problems bearing on the physical and chemical properties of cotton are being investigated at the Technological Laboratory, whose facilities are being considerably availed of by millowners who send

a large number of samples for testing. Much valuable work in general botany, physilolgy and genetics of cotton is in progress at the Institute of Plant Industry, which was established in 1924, to serve as a central research station for cotton in the black soil area of Malwa plateau. The Publicity Department of the Committee has done very valuable work in the dissemination of knowledge relating to the culture and industry of Indian cotton not only in the towns and cities by keeping the press well posted with the efforts of the Committee to improve the yield, quality and money-value of cotton, but also in remote villages of India to afford facilities and advice to the Indian cotton grower.

* * *

Scientific Research in Industry.—The Advisory Council of the Department of Scientific and Industrial Research, of which Lord Rutherford is the Chairman, directs attention in the Department's *Annual Report* just issued (H. M. Stationery Office, 3/- net) to important developments in the outlook of industry in Great Britain. The last five years have witnessed, the report states :—

" the fruition of the policy adopted by several large industrial undertakings of setting well-balanced teams of research workers, including chemists, physicists, engineers and where necessary biologists to solve a particular problem or to develop a new product. This method of attack has led to the steady improvement of the efficiency of electric lamps, to the position this country has won in high-definition television, to the development on a commercial scale of the huge plant for the conversion of coal into oil by hydrogenation, to the growth of the plastics industry and to many other important advances. This country has never been lacking in men of genius whose inventive capacity can give birth to the ideas which bring about industrial advances. What is new, in this country in present times, is the way in which industry has taken up these new ideas and brought them to the stage of industrial application by team work in which the scientists, the technical men and in fact all the departments into which a great business is organised have worked side by side in the practical attainment of an objective."

The future, the report continues, no longer lies with industries content to make sporadic advances at the call of the brilliant individualist. Co-operation, team work and an extensive organisation on the technical side are essential for success.

* * *

The Total Solar Eclipse of June 8, 1937.—One of the largest and most completely equipped expeditions ever organised to study a total eclipse of the sun will be sent by the *National Geographic Society* and the *U. S. Navy* to observe the unusual solar eclipse of next June 8 from a tiny coral atoll in the Phoenix Islands far out in the midst of the Pacific Ocean.

This will be the longest eclipse of the sun visible from the earth in 1,200 years, having a maximum duration of totality of 7 minutes and 4 seconds. This eclipse also will " end the day before it starts ". Its path will cross the International Date Line in the mid-Pacific, so that it will begin on June 9, but end on June 8.

The scientific leader of the expedition will be Dr. S. A. Mitchell, Director of Leander McCormick Observatory, University of Virgina. Captain J. F. Hellweg, Superintendent of the U. S. Naval Observatory, will have charge of the Navy's participation. Other members of the group will include : Dr. Paul A. McNally, Director of Georgetown College Observatory ; Dr. Heber D. Curtis, Director of the University of Michigan Observatory ; Dr. Floyd K. Richtmyer, of Cornell University ; Dr. Irvine C. Gardner, National Bureau of Standards ; Mr. John W. Willis, of the Naval Observatory, and a photographer from the National Geographic Society. A naval surgeon qualified to carry out the work of a naturalist probably will join the party at Hawaii.

The expedition's scientific programme will be one of the most complete and comprehensive ever carried out by eclipse observers. Special attention will be devoted to observation of the sun's corona, visible only during a total eclipse, and the chromosphere, or outer layer of the sun, by photographing the " flash spectrum," which permits the determination of the heights to which vapours rise from the surface of the sun.

Dr. Gardner will take with him the same eclipse camera of his own design which he took to Russia, which employs a new type of lens and with which he obtained very successful photographs of last June's eclipse. He also will make photographs in colour. The Naval Observatory party will be especially interested in observing the exact times at which the eclipse begins and ends. This will serve as an important check on calculations of the movements of the heavenly bodies, which is the official function of the Naval Observatory and which aids it in perfecting knowledge of the motion of the moon and hence in predicting the time of future eclipses.

The National Broadcasting Company, co-operating with the expedition, will set up a radio transmitting station in the island and by short-wave radio, a description of the eclipse will be carried to the United States, sent over a coast to coast network and rebroadcast to other parts of the world.

* * *

Rare African Birds.—An expedition to study and photograph the Crowned Hawk-Eagle of South Africa, which is, for its size, one of the most ferocious and evil-looking birds in the world, will be conducted under the auspices of the *National Geographic Society*, by Captain C. W. R. Knight, of England. The expedition will spend approximately five months in the field, and will make photographic studies of other unusual birds and small mammals of South Africa.

Captain Knight discovered a region, in which Crowned Hawk-Eagles nest during a trip into the back country of South Africa several years ago. The birds have a lesser wing-spread than some of the eagles that live in open country, and more rounded wings, permitting them to manœuvre in forest country. They have unusually large and powerful feet with which they kill surprisingly large animals, even small deer. The birds have been called " the ogres of Africa's monkeys," and under their nests in lofty yellow-wood trees are found many skulls of these creatures. In

order to obtain photographic records of the birds, Captain Knight and his assistants will have to construct blinds in trees near their nests, perhaps 80 to 100 feet above the ground; or on cliffs, if the situation of the nest permits. In these blinds long vigils will be kept with still and motion cameras equipped with telephoto lenses. An effort will be made to obtain a complete photographic record of the lives of the birds from the time they are hatched until they take to the air and begin to prey on the animals of the surrounding country.

Another unusual South African bird to be studied and photographed by Captain Knight is the Hommer-Kop (Hammer-Head), a smallish brown bird about the size of a pheasant, belonging to the stork tribe. The most interesting thing about the Hommer-Kop is its little-known nest, a huge affair like a cart-load of sticks, but with entrance tunnel and "apartments" carefully plastered with hard-setting clay.

Still another unusual feathered creature that will come before Captain Knight's camera lenses is the Secretary Bird of Rhodesia which is fast becoming rare. A member of the vulture tribe with stiltlike legs, this bird kicks snakes, lizards, and moles to death, then swallows them whole.

* * *

International Brewing Abstracts.—With daily duties claiming attention and a voluminous technical press publishing thousands of new papers every year, brewers and brewery chemists must find it increasingly difficult to keep track of the latest developments in the principles and practice of their profession. It is to meet this difficulty that International Brewing Abstracts (I.B.A.) has been evolved. I.B.A. publishes every month some twenty abstracts of the most significant papers in the current journals; these abstracts are each printed on separate cards for filing and bearing index numbers, the system being designed to make instantly available in card-index form a rapid and condensed survey of current information available on all aspects of brewing. The original German edition (*Kartothek der Brauerei-Literatur*) which has been running under the direction of Dr. F. Kutter since 1928, has met with widespread appreciation that the publishers, after launching a French edition in 1934, have begun to issue the English edition now under notice. The Wahl-Henius Institute, Chicago, and a number of English, French, German, Danish and American brewing technologists, collaborate in its production. There is no lack of testimony to the value of this thoroughly practical abstracting service, which should prove as useful to English-speaking brewers and brewery chemists as it has done to those abroad. —(*J. Institute Brewing*, 1936, **42**, 445.)

* * *

Fossil Wood.—Recently a fossil wood from Nowgong Forest Division in Assam has been identified as a species of *Gluta*. Geologically the fossil wood is said to be of Tertiary age—an age which goes back to as many as 60 million years. In this connection it is of interest to note that *Gluta* does not now grow in Assam—its distribution in India being confined to Burma and South India. From the fossil woods that have been so far found it appears that once upon a time there was an extensive forest of *Gluta* in Burma, Assam and Bengal. Why and how this has disappeared from the two latter provinces is a mystery. Perhaps the ecologists will be able to throw some light on this problem. (*Indian Forester*, 1936, **63**, 167.)

* * *

We acknowledge with thanks the receipt of the following :—

"Nagpur Agricultural College Magazine," Vol. 2, No. 2.
"Agricultural Gazette of New South Wales," Vol. 48, Nos. 2 and 3.
"Journal of Agricultural Research," Vol. 53, No. 11.
"Monthly Bulletin of Agricultural Science and Practice," Vol. 28, Nos. 2 and 3.
"Journal of Agriculture and Live-Stock in India," Index to Vol. 5.
"Allahabad Farmer," Vol. 11, No. 2.
"Journal of the Royal Society of Arts," Vol. 85, Nos. 4396–4400.
"Biochemical Journal," Index to Vol. 30 and Vol. 31, No. 2.
"Journal of the Indian Botanical Society," Vol. 16, Nos. 1 and 2.
"Chemical Age," Vol. 36, Nos. 921–925.
"Journal of Chemical Physics," Vol. 5, No. 3.
"Berichte der Deutschen Chemischen Gesellschaft," Vol. 70, No. 3.
"Russian Journal of General Chemistry," Vol. 6, No. 12; Vol. 7, No. 1.
"Experiment Station Record," Index to Vol. 74, and Vol. 76, No. 2.
"Transactions of the Faraday Society," Vol. 33, Part 3.
"Indian Forester," Vol. 63, No. 3 and Index to Vol. 62.
"Forschungen und Fortschritte," Vol. 30, Nos. 6–8.
"Marriage Hygiene," Vol. 3, No. 3.
"Journal of the Indian Mathematical Society," Vol. 2, No. 5.
"Medico-Surgical Suggestions," Vol. 6, No. 3.
"Review of Applied Micology," Vol. 16, No. 2.
"Journal of the Bombay Natural History Society," Vol. 39, No. 3.
"Nature," Vol. 139, Nos. 3512–17.
"Journal of Nutrition," Vol. 13, Nos. 2–3.
"Indian Journal of Physics," Vol. 20, No. 1.
"Research and Progress," Vol. 3, No. 2.
"Canadian Journal of Research," Vol. 15, Nos. 1 and 2.
"Journal of Research, National Bureau of Standards," Vol. 17, Nos. 3–5.
"Science and Culture," Vol. 2, No. 9.
"The Sky," Vol. 1, No. 5.
"Science Forum," Vol. 2, No. 1.
"Scientific American," Vol. 156, No. 4.

Government of India Publications :—

"Indian Trade Journal," Vol. 133, No. 1603; and Vol. 134, Nos. 1605–1607.
"Bulletin of Industrial Research," No. 6.

ACADEMIES AND SOCIETIES.

Indian Academy of Sciences:

March 1937. SECTION A.—CH. V. JOGARAO: *An Optical Method of Determining the Relative Coagulating Powers of Electrolytes.*—The coagulation of arsenic sulphide sol in the presence of various electrolytes has been studied by measurements of depolarisation of the light scattered by the sol. R. ANANTHAKRISHNAN: *The Raman Spectra of Crystal Powders.—IV.—Some Organic and Inorganic Compounds.* The Ramaa spectra of a number of organic and inorganic crystal powders have been obtained by employing the technique of complementary filters. Many new frequencies have been recorded. The significance of the results is discussed. S. R. SAVUR: *A New Solution of a Problem in Inverse Probability.*—A new "statistical" solution of the problem in inverse probability referred to by Karl Pearson as "the fundamental problem in practical statistics". R. K. ASUNDI AND R. SAMUEL: *Some Remarks on the Birge-Sponer Method of Vibrational Extrapolation.* R. K. ASUNDI AND R. SAMUEL: *Note on the Structure of N_2^+ and its Bearing on the Theory of Valency.* S. RANGASWAMI AND T. R. SESHADRI: *Geometrical Inversion in the Acids Derived from the Coumarins. Part IV. The Behaviour of the Ethers of the* Cis *and* Trans *Acids.* B. L. GULATEE: *Gravity, Geoid and Plumb-Line Deflections in Mountainous Areas.* INDER CHOWLA: *On $\Gamma(k)$ in Waring's Problem and Analogous Functions.* S. ZAFARUDDIN AHMED AND R. D. DESAI: *Heterocyclic Compounds. Part I.—Coumarins from Cyclopentanone-2-Carboxylate and 4-Methyl-cyclopentanone-2-Carboxylate.* R. ANANTHAKRISHNAN: *The Raman Spectra of Some Simple Molecules. (Dimethyl Ether, Phosgene,* n*-Butane, Ethylene Diamine, Ethylene Glycol, Ethylene Dichloride, Ethylene Dibromide, Acetylene Tetrachloride, Acetylene Tetrabromide and Hexachloroethane.)*—The Raman spectra of the above substances have been studied and the problem of "free rotation" in ethane derivatives is discussed in the light of these results. C. V. RAJAM: *Microphone Acutated Thyratron Relay.*—Details are given of a thyratron valve amplifier circuit which can be used as a simple sound intensity meter.

March 1937. SECTION B.—A. C. JOSHI AND L. B. KAJALE: *Fertilisation and Seed Development in Amarantaceæ.*—A detailed account of embryogeny for the family Amarartaceæ is given. C. BHASHYAKARLA RAO: *A New Species of* Anabæna (Anabæna ambigua *Sp. Nov.*).—A peculiar blue-green alga collected from a few ponds near the Benares Hindu University grounds, has been completely studied and recorded. The results justify its being considered a new species of *Anabæna.* BENI CHARAN MAHENDRA: *A Note on the Distinctive Characters of the Indian Species of* Cylindrophis *Wagler.* A revised key for the genus *Cylindrophis* Wagler, drawn up by Dr. Malcolm Smith has been presented. JOGENDRA NATH MISRA: *The Zygnemaceæ of Kashmir—I.* The first of the series of papers on the algal flora of Kashmir. 19 forms have been recorded and out of these 4 species, 4 varieties and 6 forms are new.

National Institute of Sciences, India:

March 25, 1937.—The Easter Meeting of the National Institute of Sciences of India was held at Allahabad, PROF. M. N. SAHA presiding.

DR. G. R. TOSNIWAL gave an account of the radio studies of the upper atmosphere which was followed by a theoretical paper by the President and MR. R. N. RAI on the propagation of radio waves from the Ionosphere. DR. S. B. DUTT, Reader in Chemistry in the Allahabad University, and his pupils contributed six papers on the chemical analysis of Indian Medicinal Plants. DR. BHATTACHARYA gave an account of his work on the Zoology of Golgi bodies. PROF. BURRIDGE reported cases of Tuberculosis which he had discovered among frogs at Lucknow and propounded a new theory of colour vision. MR. P. C. GUPTA, a student of Prof. Burridge, reported the results of his experiments on the Sodium Iodo Acetate.

National Academy of Sciences, India:

March 2, 1937.—N. R. DHAR AND E. V. SESHACHARYULU: *Nitrogen Fixation and Azotobacter Count on the Application of Carbohydrates and other Energy Materials to the Soils.* S. K. MUKERJI: *Changes in Soil Nitrogen after the Addition of Fresh Cowdung to Soil.*—Fresh Cowdung has been shown to fix atmospheric nitrogen. Molasses accelerate the oxidation of cowdung in soil and increses the total amount of nitrogen fixed. S. PRADHAN: *The Alimentary Canal of Coccinella Septumpunctata.*—The excretory Malpighian tubules reassociated with the high gut in the lady-bird beetle, act as a filter for eliminating waste nitrogenous material contained in the liquid which is mechanically pressed out of the hind-gut into body-cavity. BIRBAL SAHNI AND K. P. RODE: *Fossil Plants from the Deccan Intertrappean Beds at Mohgaon Kalan (C. P.), with a Note on the Geological Position of the Plant-bearing Beds.*—The affinities of the fossil flora of the Deccan Intertrappean Beds strongly support the view, recently revived by Professor Sahni, that the earliest volcanic lavas (traps) of the Deccan were poured out in the Eocene period, that is, soon after the dawn of the Tertiary era. This view was held by the pioneer geologists a hundred years ago, but during the last seventy years, as the result of work done by the Geological Survey of India, the opinion has grown that the earliest traps were older, and of Cretaceous age. This official view of the Survey, although based only upon indirect evidence, has been accepted by geologists, all over the world; but it is opposed to the direct evidence of the fossil plants which have decided Tertiary affinities.

In the first part of this paper PROFESSOR SAHNI shows that the fossil flora of Mohgaon Kalan near Chindwara, originally discovered by Mr. Rode, has Tertiary affinities, like the flora of the rest of the Deccan Intertrappean series. In the second part Mr. Rode describes the geology of the area and shows that the fossiliferous beds really belong to the basal part of the series. This latter fact is important, because if the basal part of the series is of Tertiary age, then there can be

no ground whatever for classifying the higher strata as Cretaceous.

The value of fossil plants as an index of geological age is now being increasingly recognised in India, where the ages of some of the most important rock systems, containing coal, oil, salt and other mineral products, have been elucidated by a study of their plant fossils.

The Indian Mathematical Society:

(*Journal*, 2, *No.* 4.)

V. GANAPATHY IYER: *On Integral Functions of Finite Order and Minimal Type.*—Let $[z_n]$ be a sequence of distinct complex numbers tending to infinity and arranged according to non-decreasing moduli. Let $\sigma(z)$ be the canonical product with simple zeros at z_n. The index of distribution (I.D.) of $[z_n]$ is defined as the greatest lower bound of numbers h such that

$$\Sigma \left| \frac{1}{\sigma'(z_n) z_n^{h+1}} \right|$$

converges. In previous papers, the author has discussed the properties of integral functions bounded at a sequance of points with finite (*i.e.*, not $+\infty$) I.D. The object of the present paper is to discuss certain cases where the I.D. may be infinite while the value of the function at $[z_n]$ is subjected to more stringent hypothesis than mere boundedness. (2) D. D. KOSAMBI: *Differential Geometry of the Laplace Equation.*—Given a linear partial differential equation $a^{ij}u_{,i,j} + b^i u_{,j} = 0$, the necessary and sufficient conditions are worked out that it should be the Laplace equation associated with some Riemann space. R. VAIDYANATHASWAMY: *A Note on the Morley-Peterson Theorem.*—In this note, the real significance of the well-known Peterson-Morely theorem about a skew hexagon is brought to light, thereby affording not merely a new proof of the theorem, but also its generalisation. S. MINAKSHI-SUNDARAM: *Tauberian Theorems on Dirichlet's Series.*—Two results due respectively to K. Ananda Rao (*Proc. L.M.S.* (2) 34: Theorem 4) and V. Ganapathy Iyer (*Annals of Math.*, **36**, Theorem 4) are generalised. Some remarks are made about the application of these theorems to obtain certain precise results, anticipated by Ananda Rao, on the abscissæ of summability of Dirichlet's series. K. RANGASWAMI: *On the Pedal Quartics of a Quadric.*—A paper in continuation of his paper on the Theory of Normals to a quadric in the *Proc. Ind. Ass. Sc.*, 1. R. C. BOSE: *Analogue of a Theorem of Blaschke.*—Let $r = r(s)$ be the vector equation of a plane curve V, s denoting the affine length. Let $r_1 = r'(s)$, $r_2 = r''(s)$ be the vector equations of the tangent and curvature forms V′, V″. Let ρ be the radius of curvature at any point of V, and r_1, r_2 the lengths of the radii vectors to the corresponding points on V′ and V″, and p_1, p_2 the lengths of perpendiculars from the origin to the tangents at these points. Then it is proved that $r_2 = l^{-\frac{1}{3}}$; $p_1 = l^{\frac{1}{3}}$ where l is the semi-latus rectum of the osculating parabola to V. It is also proved that "on an elliptic convex oval we can find at least three pairs of points, such that the latera recta of the osculating parabolas are equal, and the affine normals are parallel". N. G. SHABDE: The object of this paper is to collect a number of results involving the confluent hypergeometric functions such as the K-functions, D_n functions, Laguerre functions and Bessel functions, some of the results being obtained by operational methods.

Indian Chemical Society:

December 13, 1936.—BALWANT SINGH AND IJAZ ILAHI: *Potentiometric Studies in Oxidation Reduction Reaction. Part I. Oxidation with Potassium Iodate.* HARENDRA KUMAR ACHARYA: *Properties of Activated Sugar Charcoal Coated with Various Substances. Part I. Liberation of Acid and Alkali by the Action of Neutral Salts in Relation to the Surface Charge.* R. D. DESAI AND M. A. WALI: *Dihydroresorcinols. Part IV. The Condensation of Phenyl dihydroresorcinol with the Aromatic Aldehyde.* MAHENDRANATH RUDRA: *Studies in Vitamin C, Part II. The Vitamin C Contents of the Liver and Muscle of Some Indian Freshwater Fish.* MAHAN SINGH AND MANOHAR SINGH: *Studies on Optical Activity and Chemical Constitution. Part III. Optically Active Acids and Bases.* K. M. SIL, G. C. ROY AND P. N. DAS-GUPTA: *A New Method for the Separation of Lead from Copper and their Subsequent Estimations.* D. N. CHATTERJI, K. R. GANGULY AND M. Z. FARUQI: *Estimation of Small Quantities of Arsenic in Medicolegal Cases.* SHRIDHAR SARVOTTAM JOSHI AND N. HANUMANTHA RAO: *Studies in the Coagulation of Colloids. Part XV. New Aspects of Gold Sol Coagulation.*

January 1937.—SIR UPENDRANATH BRAHMACHARI: *Certain Aspects of the Chemotherapy of Synthetic Hypnotics.* K. N. GAIND: *Synthesis of New Local Anæsthetics. Part I.* SUDHAMOY MUKHERJEE: *The Electrochemical Properties of Palmitic Acid Hydrosols.* DUHKHAHARAN CHAKRAVARTI AND BHOWNI CHARAN BANERJEE: *On the Constitution of Nitro-β-Methylumbelliferone Methyl Ether and of Chlororesorcin.* P. R. KRISHNA SWAMY AND B. L. MANJUNATH: *Chemical Examination of the Roots of* Aristolochia Indica, *Linn.—Part III.* Isolation of the Alkaloid Aristolochine. GOPAL LAL MAHESWARI AND J. B. JHA: *Potentiometric Estimation of Lead with Sulphide Solutions.* M. B. RANE AND K. KONDIAH: *A Method of Qualitative Analysis without the Use of Hydrogen Sulphide.* HIRENDRA NATH BANERJEE: *Chemical Examination of* Clerodendron Infortunatum—*Part I.* K. P. DAVE AND K. S. NARGUND: *A Note on the Preparation of β-4-Methoxy-1-napthoylpropionic Acid.*

Indian Botanical Society:

March 1937.—F. BOERGESEN: *Contributions to a South Indian Marine Algal Flora. I.* K. BISWAS: *Two New Flowering Plants.* B. N. SINGH AND R. B. SINGH: *The Role of Leaf Water-content, Soil Moisture and Plant age on Transpiration of Crop Plants.* B. N. SINGH AND S. C. CHAKRAVARTI: *Unequal Absorption of Ions and Their Rate and Order of Entry from a 3-Salt nutrient.* V. VENKATESWARALU: *A Note on the Development of the Embryo-sac in* Phrynium capitatum.

C. V. KRISHNA IYENGAR: *Development of Embryosac and Endosperm-Haustoria in Some Members of the Scrophularineæ.—Part I.*—An account of *Sopubia delphinifolia* G. Don. and *Alonsoa* sp. M. O. P. IYENGAR: *Fertilization in* Eudorina elegans *Ehrb.*

Meteorological Office Colloquium:

February 9, 1937.—MR. S. BASU of the Indian Meteorological Survey, on his return from the meetings of the Regional Meteorological Commission for the Extreme Orient held at Hongkong in January 1937, gave an account of the work done at the meetings of the Commission.

February 16 and 18, 1937.—The Colloquium was addressed by LT.-COL. E. GOLD, D.S.O., F.R.S., (of the London Meteorological Office, and President of the International Commission for Synoptic Weather Information), who visited India on his way back to London from the Hongkong Conference. In his first address, he gave a thrilling and valuable account of his recollections of meteorological work in France during the years of the Great War while for the theme of his second address he chose "Weather Forecasting".

March 2, 1937.—DR. S. N. SEN: *Long-range Forecasting of the Monsoon with Special Reference to the Everest Expeditions.*

March 16, 1937.—DR. C. W. B. NORMAND: *Criteria of Stability of Particles and Layers of Air in the Atmosphere.*

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Bombay University:

Royal Institute of Science, Bombay.—Prof. G. R. Paranjpe, Head of the Physics Department, has been granted leave from 20th June to 9th October 1937.

Dr. N. R. Tawde, Lecturer in the Physics Dept., will act as Professor of Physics during the absence of Prof. Paranjpe on leave.

Dr. T. S. Wheeler has been granted the Honorary Degree of M.Sc. by the National University of Ireland.

Under the University Bifurcation of Arts and Science courses, the Institute will discontinue teaching upto Intermediate standard from June 1937. These classes will be transferred to the Elphinstone College.

University of Mysore:

1. *Personnel.*—Dr. E. P. Metcalfe, D.Sc., Vice-Chancellor, has, in continuation of the long vacation from the 1st April 1937, been granted leave preparatory to retirement from service. Mr. N. S. Subba Rao, M.A., Bar-at-Law, Director of Public Instruction in Mysore, has been appointed to be in charge of the duties of the Vice-Chancellor in addition to his own during the above period or until further orders.

Mr. A.B. Mackintosh, M.A., Professor of English, Maharaja's College, Mysore, has been granted five months' combined leave from the 24th June 1937, in continuation of the long vacation.

2. *Senate.*—The annual meeting of the Senate was held on the 22nd March 1937. Among the propositions that were passed, mention may be made of the following:—

(i) Introduction of an ordinance regulating the course of study in German for B.Sc. Honours students.

(ii) Institution of a separate minima for the papers, thesis and *viva voce* for the Master's Degree examination.

(iii) Revised syllabus in Mathematics for the Intermediate, B.A., and B.Sc. Degree examinations.

(iv) Provision for the admission of L.M.P. diploma holders to the M.B.B.S. degree course, under certain conditions.

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